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SCIENTIFIC MAN-POWER AND SCIENCE-TEACHING

IN opening an adjournment debate in the House of Commons on the shortage of science teachers on October 21, Mr. Bernard Braine quoted Mr. Robert Birley's statement in his presidential address to Section L (Education) at the British Association meeting at Liverpool, to the effect that the shortage is so serious as to render futile any talk of developing the scientific strength of Britain or any planning of institutes of technology or the like until it is remedied. Mr. Birley's address, however, was not the only one at the British Association meeting which directed attention to this shortage, nor was the passage quoted by Mr. Braine possibly the most important remark which Mr. Birley made in this connexion. One reason that Mr. Birley gave for regarding the shortage as serious was that more teaching of science in the grammar schools is desirable not merely to ensure a sufficient supply of scientists but, not less important, to help provide those entering on other careers with some understanding of science. Mr. Birley believed that the inability of the Civil Servant to understand the scientist is a more serious danger than that of the scientist to understand the Civil Servant.

The question of the shortage of science teachers should, in fact, be approached from this wider angle, and other references at the British Association meeting, notably Mr. E. Yerbury's address on the teaching of science in schools (Section X, Assembly of Corresponding Societies) and Prof. G. R. Clemo's presidential address to Section B (Chemistry), together provide the right perspective. Mr. Braine, indeed, covered the ground very reasonably. Like Mr. Birley, he recognized that it is not entirely a matter of salary differentials. It will not suffice, even if it were possible to avoid the attendant difficulties and repercussions, to raise the salaries of science masters to a figure high enough to counteract the financial inducements of industry. Other factors also help to determine whether or not able scientists enter the teaching profession.

Mr. Braine stressed two points, both of which were emphasized by Prof. Clemo. First, he thought that there is a general impression that the prospects of a headship are less for a science teacher than for an arts teacher. Prof. Clemo had remarked on the absence of science headmasters in our grammar schools: of twenty-five such schools in Newcastle and Northumberland, only four had headmasters who had graduated in science and two others had headmasters who had graduated in mathematics; of the remainder, ten had graduated in classics, three in English and three in history.

More important in Mr. Braine's view is the fact that a teaching career deprives the honours graduate of opportunities for specialist study and facilities for research. Here again Prof. Clemo also suggested that the universities could possibly make science-teaching more attractive as a career by encouraging research by science masters in schools. He referred to the research which was carried out, to their great credit,

at Clifton College and Dulwich College in the latter part of the nineteenth century. A paper on research in schools which Dr. A. G. Lowndes read before Section L (Education) at the Birmingham meeting of the British Association in 1950 was, in fact, concerned with research carried out by the actual teaching staff and not by the pupils themselves, and he referred specifically to the occasional publication in the *School Science Review* of articles based on research carried out by the authors in schools.

In this connexion, Mr. Braine suggested that the practice should be adopted of allowing the honours graduate, whether in science or in arts, at least one day a week for research, upon application to the local education authority; that liaison between such teachers and the appropriate universities should be encouraged; and that similar arrangements might be made alternatively to facilitate the graduate engaging in industrial research. He thought that great advantages might accrue from teachers participating in such research and from industrial research chemists assisting in teaching. If such graduates prosecuted their research at a university, then he considered that the cost of material and equipment should be borne by the university as in ordinary postgraduate research.

Mr. Braine is obviously advocating the extension to the science teacher of honours grade of some of the facilities for research and consulting work which teachers at some of the technical colleges have enjoyed, although the question of equipment and materials might prove less simple than he implied, and facilities for research grants might not be so readily available. His constructive suggestions, however, drew no reply from the Parliamentary Secretary to the Ministry of Education, Dr. Kenneth Pickthorn, who replied for the Government. He could only say that the urgency of the situation is fully appreciated by the Ministry and that the inquiry now being carried out by the National Advisory Council on the Training and Supply of Teachers would be finished very shortly. Meanwhile, in each of the past three years there has been a small increase in the number of men graduates teaching mathematics and science, and the number of women graduates has remained steady. A special return showed that during the twelve months ended October 1952 there was an increase of 2·6 per cent, from 8,278 to 8,490, in the number of teachers with degrees in mathematics and science employed full-time in all maintained and assisted secondary schools offering courses leading to the General Certificate of Education. Dr. Pickthorn admitted that the situation might well be worse in a few years time, and he also referred to the appointment by the Secretary of State for Scotland of a committee, with Sir Edward Appleton as chairman, to consider and report on the causes and effects of present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and to suggest remedies.

Dr. Pickthorn ignored the suggestions made by Mr. Braine; but they merit careful examination, both in the light of Dr. Lowndes's comments and of the observations which Mr. Yerbury made to the Assembly of Corresponding Societies at Liverpool. Dr. Lowndes took the pragmatic view that if a science teacher undertook research, the primary objective should be to increase his efficiency as a teacher of his own particular subject: a schoolmaster's research work, he maintained, must be dictated by his own branch of teaching. It might be added that permission for the prosecution of research is more likely to be granted on such grounds by local education authorities than on the grounds of advancing knowledge.

Dr. Lowndes made it clear in his paper that he was not thinking simply of research carried out in the vacations, but of research carried out in term-time in the school laboratories. While pointing out very clearly that schools are not research institutions and are under no obligation to provide facilities for research, he argued that any man in charge of the higher teaching in any branch of science would increase his efficiency enormously by undertaking research. For that reason any efficient school should realize that it is to its advantage to encourage research; but Dr. Lowndes held that the initiative should come from the teacher and not from the school. Moreover, he thought that the ideal subject for research is some branch of study which incorporates biology, chemistry and physics with a little mathematics.

In thus stressing the importance of the subject-matter in relation to the interests and needs of the students in the higher forms rather than the interests of the science teacher *per se*, Dr. Lowndes made a point similar to that which Mr. Yerbury made at Liverpool in a slightly different connexion. Mr. Yerbury maintained that biology and general science rather than the physical sciences should constitute the approach and main content of science-teaching in schools, on the ground that these are more closely related to the environment and needs of the pupil. On this argument the content most in line with the needs and interest of the student is that which is most likely to afford the science teacher opportunities for research which can be carried out in school laboratories without excessive difficulties in regard to material or equipment.

If the encouragement of science teachers to undertake research in this or in other ways did no more than kindle or sustain enthusiasm, it might well be worth while. All depends, however, upon the quality of the teacher. An honours degree is no guarantee either of teaching ability or enthusiasm; and this factor must never be overlooked, no matter how far the practice of research in schools develops. The interests of the pupils must be the first consideration: if we can obtain the right men and women as science teachers and support them with the measure of public appreciation and understanding for which Mr. Yerbury pleaded, lack of funds is unlikely to stand in the way of their prosecution of research.

There is, however, a further aspect of research in schools which Dr. Lowndes specifically excluded from his paper but which may well be of increasing importance in this connexion. To the teacher with

both the enthusiasm for his subject and the interest in his pupils which are essential, the carrying out of research by his pupils may also offer some genuine satisfaction. There have been a number of outstanding and successful examples of such research in recent years, and developments here may possibly be easier than along the lines indicated by Dr. Lowndes or Mr. Braine. The observations on the natural history of starlings recording the results of twenty-five years bird-ringing at Bootham School, York, under the direction of Mr. Clifford J. Smith, is one example of activities which the British Trust for Ornithology has done much to foster during the past twenty years. There is probably still room for more schools to co-operate in such field investigations; nor are the opportunities offered by the Field Study Centres of the Council for the Promotion of Field Studies as yet fully utilized even by the schools in the regions in which the Centres are situated. Such ventures as the oceanographic expedition in the North Sea organized early this year for science sixth-form boys from the Watford Grammar School are examples of what a little enterprise and imagination can do both to indicate the nature of scientific work to the schoolboy and provide opportunity of participating in the making of observations of value to science.

Other examples of such activities may be seen in the British mountain weather survey completed early in September, in which for some twelve weeks five high-altitude weather stations in the Cairngorms were manned by teams of undergraduates and senior schoolboys. This survey, which it is hoped to extend into other seasons, is of a type which should appeal to schools and to science masters looking for some form of investigation of scientific value. In the Brathay Exploration Group, both schoolboys and boys from industry have been co-operating since the summer of 1947 in field studies of the tarns, and especially the corrie tarns, in the Lake District, as well as in similar observations on an expedition to the Jotunheim in 1950. The schools meteorology scheme of the Royal Meteorological Society also offers the possibility of achieving work of real value to science, provided enough schools co-operate to make the study sufficiently representative.

While developments along such lines hold promise of satisfaction to the science teacher anxious to contribute to the advance of science as well as of furthering a keener appreciation of the true nature of scientific work on the part of the scholars engaged in it, too much weight must not be given to the factor of research in considering the question of the supply of science teachers. It should not, indeed, be disdained, as it was by Dr. Pickthorn. The initiative should rightly come from the science teacher, and the Minister of Education should not only be thinking about how to get a sufficient supply of science teachers keen and enthusiastic enough to be willing to undertake research: she should also be making sure that when they show such initiative it meets with an appropriate response—that it is encouraged by authority and not discouraged or thwarted.

The Minister's first responsibility is to establish the real factors of the shortage. Mr. Birley was right to point out that an increased supply of scientists (or technologists) follows an increased (or an adequate) supply of science teachers and not *vice versa*, but the facts of the situation are still incomplete. The *Times Educational Supplement* in October quoted a statement from the Science Masters' Association that 115 science posts, in some 980 schools, were still unfilled and that during the past ten years 975 science teachers had left the schools for industrial or administrative posts outside the teaching profession. The former figure is an improvement on that of 250 such posts in secondary schools unfilled at the approach of the new school year in 1952; but figures obtained in this way are neither conclusive nor necessarily impartial. Moreover, while local educational authorities are naturally not anxious to give prominence to a difficulty which may involve them in higher salaries, science teachers themselves may tend to overstress the effect of the attraction of higher salaries in industry.

For this reason it is important that the report of the inquiry instituted by the Minister last June, through the National Advisory Council for the Training and Supply of Teachers, which has just been published, should be given urgent consideration. In any event, the Advisory Council on Scientific Policy expressed itself sufficiently clearly on the subject last year for there to be no excuse for ministerial delay in the meantime in considering measures by which the status and conditions of service of science teachers could be made more attractive. Any initiative either from industry or from the science teachers themselves should be welcomed and supported by the Ministry as well as the local education authorities. All such possibilities, including also the raising of the retiring age or utilization of the services of scientists retired from other posts, should be explored with imagination and vigour.

What is already clear is that the Minister must show much more courage and resolution than was apparent in Dr. Pickthorn's speech if the country is to be assured of the supply of trained scientists that British industry requires to maintain technical progress. The exact magnitude of the shortage may be as yet uncertain. The trend is unmistakable and has been confirmed from too many sources to be questioned. The imperative need is for early action —for some immediate transfusion of science teachers of high ability. We cannot wait, as Dr. Pickthorn seems inclined to do, for the difficulty to disappear. If the grammar schools cannot cope with the present generation of science pupils, they will still less be able to cope with the flood which, even Dr. Pickthorn admitted, will come in a few years.

Nor is the question one on which the future efficiency and productivity of British industry alone turns. As Mr. Birley noted, it is increasingly important that in the government service also there should be some clear understanding of the scientist and of the way science works. That, too, must begin in the schools, and there also must begin in each generation

of pupils the task of creating that wider general understanding of science, its method, its potentialities and its limitations, which to-day is essential no less for the advance of science itself than for the realization of these full potentialities for human welfare that the application of science offers us.

A NEW ADRENAL STEROID

THERE has been a recently growing body of evidence that the isolated and characterized adrenal steroids do not themselves account for all the actions of crude adrenal cortex extract. Tait, Simpson and Grundy, working at the Middlesex Hospital Medical School, London, have devised a method for the assay of the influence of adrenal steroids on the sodium and potassium ion balance by estimation of the diminution in the ratio of sodium-24 to potassium-42 in the urine of adrenalectomized rats, over a two-hour interval after the administration of the radioisotopes. In this way they found that crude ox adrenal extract contains a substance which behaves chromatographically like cortisone but which has a much greater effect on the sodium and potassium ion balance[1]. A substance with similar properties was found to be present also in the blood of the adrenal vein[2]. Subsequent studies by Simpson and Tait and their colleagues have shown that a new adrenal steroid is responsible for these effects, and the provisional name of "electrocortin" has been suggested for this steroid[3].

The isolation of electrocortin has proved to be a difficult task, and Drs. Simpson and Tait have called into collaboration Prof. T. Reichstein, of Basle, and his colleagues, whose experience in the isolation of steroid substances is unrivalled. Dr. A. Wettstein and Dr. R. Neber, of Ciba, Ltd., Basle, also collaborated in this work, which has resulted in the preparation of pure electrocortin[4]. From one ton of cattle adrenal glands only 10–40 mgm. of electrocortin was isolated.

Electrocortin proves to be much the most active steroid so far available in maintaining an adrenalectomized dog in good health, being thirty times as active as 11-deoxycorticosterone acetate in this respect; 11-deoxycorticosterone was hitherto by far the most active isolated substance known in tests of this sort. In the sodium–potassium balance test devised by Tait, Simpson and Grundy, electrocortin is about one hundred times as active as 11-deoxycorticosterone.

Almost simultaneously, Mason and his colleagues at the Mayo Clinic, Rochester, Minnesota, have announced the isolation of a similar substance from ox adrenal extract[5]; while R. E. Knauff, E. D. Nelson and W. J. Haines, at the Upjohn Laboratories, Kalamazoo, Mich., have obtained a similar substance from pig adrenal extract[6].

Evidence about the structure of the new steroid is as yet fragmentary. It appears to be a C_{21} steroid with a Δ-4α-β unsaturated ketone grouping and an α-ketol side-chain at C_{17}. There is, in addition, a hydroxyl group the position of which has not been determined, but which appears not to be 17α, 16α or β, nor 11 or 12β. According to Knauff *et al.*, the new steroid has little or no activity in the glycogen-deposition or eosinophil-depletion tests for adrenal steroids. This observation would be in agreement with the absence of an 11β hydroxyl group.

In electrocortin we may well have the active principle of the amorphous fraction of crude adrenal extracts, the existence of which has been assumed for some time. Although electrocortin is much more active than deoxycorticosterone quantitatively, it seems likely that its actions will be qualitatively similar to those of deoxycorticosterone and of the amorphous fraction, and so any entirely new type of action will probably not be shown by electrocortin. Nevertheless, the isolation of this new steroid, springing as it does from researches at the Middlesex Hospital Medical School, has provided the solution to a problem of many years standing, and has opened up a new and important approach to the physiology of adrenal secretions.

It is unfortunate that the British pharmaceutical industry is poorly developed with respect to steroid preparation and chemistry, despite the excellent academic work in this field which has been carried out here during the past twenty-five years. Had the possibility existed in Great Britain of assisting the development of Simpson and Tait's researches on a large scale in industrial laboratories, we might have avoided yet another example of the necessity of transferring abroad for large-scale development an important new discovery made by British investigators.

[1] Tait, J. F., Simpson, S. A., and Grundy, H. M., *Lancet*, i, 122 (1952).
[2] Simpson, S. A., Tait, J. F., and Bush, I. E., *Lancet*, ii, 226 (1952).
[3] *Endocrinology*, **50**, 150 (1952). *Acta Endocrinol.*, **11**, 199 (1952); *Mem. Soc. Endocrin.*, No. 2, 9 (1953).
[4] Simpson, S. A., Tait, J. F., Wettstein, A., Neber, R., Euw, J. v., and Reichstein, T., *Experientia*, **9**, 33 (1953).
[5] Mattox, V. R., Mason, H. L., Albert A., and Code, C. F., *J. Amer. Chem. Soc.*, **75**, 4869 (1953).
[6] *J. Amer. Chem. Soc.*, **75**, 4868 (1953).

DOMESDAY BOOK RECORDS FOR EASTERN ENGLAND

The Domesday Geography of Eastern England
By Prof. H. C. Darby. Pp. xiv+400. (Cambridge: At the University Press, 1952.) 55*s.* net.

THE Domesday Book contains so many figures concerning the size and value of land holdings, the extent of wood, meadow and pasture, and the existence of mills, fisheries and salt-pans for the greater part of England, that generations of historians have wished that this information could be incorporated in maps that would illustrate the physical appearance and something of the economic activity of England about the year 1100. What was lacking was time for the calculations and certainty as to the meaning of the terms in which Domesday quantities were expressed. Prof. H. C. Darby, as this volume of four hundred pages and the promise

of four more to come show, obviously has the time, but has he the certainty ?

In this century Domesday studies have done more to suggest the manner in which the text was arranged from the original local returns, and to speculate on the purpose of the document, than to advance understanding of its terminology. The acre of Domesday is still an unknown quantity. Its linear measurements are obscure. The value of land is expressed in terms that still escape us ; the plough-land remains an abstraction. While detailed study of the text has enabled us to remark upon the errors of the eleventh-century clerks, it has done little to overcome certain problems they set posterity : it is not always possible, for example, to get the total number of hides for a vill or hundred ; several vills may be grouped under one place-name, so that the local density of stock and population is obscured ; features may be mentioned with the place responsible for them in a fiscal, not a physical, sense—thus Prof. Darby is reduced to mapping some salt-pans in Lincolnshire "where it was physically impossible for them to have been located" (p. 69), for he rightly maps the Domesday Book errors and all, rather than incorporate the corrections of its commentators. The geographer is not even helped by the work done on documents associated with the Domesday Book like the "Inquisitio Eliensis", nor by the special treatment of Norfolk, Suffolk and Essex in the more capacious "Little Domesday" ; the figures he needs are as often confused as elucidated.

Prof. Darby liberally accepts these disadvantages. Plough-lands are so vague that "we cannot wholeheartedly accept them as giving a sure indication of the relative distribution of the arable land in different parts of the county [Lincolnshire]" (p. 43). "From the nature of Domesday Book it is likely that no two people will arrive at identical totals" of population (pp. 47–50). After plotting marshlands in Lincolnshire on a special map, he confides that "It is impossible to believe that the fenland did not contain many more stretches of marsh of some value in the economy of the villages of the county" (pp. 64–6), and his comment on a map of the fisheries is that "it is impossible to believe that these Domesday entries represented the total fisheries of eleventh-century Lincolnshire" (p. 68). In fact, "In the light of all the uncertainties, it would be more correct to speak not of 'the Domesday Geography of England', but of 'the Geography of the Domesday Book' " (p. 2).

What we have, then, are the data in Domesday Book "most relevant to an understanding of landscape and economic geography" for Lincolnshire, Norfolk, Suffolk, Essex, Cambridgeshire and Huntingdonshire arranged county by county with tables and maps plotting place-names, plough-teams, population, woodland, meadow, marsh (Lincolnshire, Cambridgeshire), fisheries, salt-pans, waste, sheep (Suffolk, Norfolk, Essex) and mills. These give a picture of the relative prosperity of different regions and the overall economic activity of the countryside that is not really misleading on the scale employed for the maps—12½ miles to the inch. At the end of each chapter is a useful general survey of the main geological divisions, and the book ends with a description of the eastern counties as a whole, with reference to each feature. Each carefully drawn map has its limitations carefully pointed out in the text, and the conclusions to be drawn from it are most temperately expressed. In Lincolnshire, it is shown, for example, that "In general, the areas of sparse population coincide with the areas of few plough-teams", and from a map giving the distribution of sheep (twenty to the dot) in Norfolk, it is stated that "the first thing that stands out is that there were fewest sheep where there was most wood". It is nice that someone should have done all this work, but one hopes that Prof. Darby will not wall up other qualities besides his humour in the monument that he is building to patient scholarship.

J. R. Hale

PLANT GROWTH-REGULATING SUBSTANCES

Plant Growth Substances

By Prof. L. J. Audus. Pp. xix+465+42 plates. (London : Leonard Hill, Ltd., 1953.) 42*s*.

THE discovery that 3-indolylacetic acid is a growth hormone of plants and that many structurally similar compounds can also affect growth processes has opened up wide fields of chemical, physiological and agricultural research. The volume of literature relating to growth substances which has appeared during the past two decades is already very extensive, and it was by no means an easy task to prepare an up-to-date and readable account of the subject within a single volume. The author has done this, however, in a most creditable manner. His book represents the first really comprehensive effort in this field ; others, which have been published in the United States, have dealt mainly with practical applications with somewhat superficial treatment of fundamental, chemical and physiological aspects. Another very welcome feature of this book is that proper attention has been devoted to the contributions of European as well as American workers in this field.

The basis upon which the book has been written is that a knowledge of the physiological principles underlying the action of growth substances is essential to all who are interested in these materials. Chapter 1, dealing with the nature of plant growth, gives an excellent introduction along these lines and leads logically to a consideration in Chapter 2 of the natural auxins and their functions within the plant. The evidence relating to the existence of auxins *a* and *b* is carefully and fairly reviewed. Methods of assessing the activity of auxins are also considered here. Although details are only briefly given, mention might have been made of the fact that, in general, synthetic growth substances only induce poor responses in Went's *Avena* test. In the *Avena* straight-growth test certain workers would question whether the presence of sugar is necessary. Moreover, Bentley's modifications of this test also deserve mention. The chapter which follows, dealing with chemistry of the auxins, is not to be regarded as an essential part of the book, being provided only for those with particular interests in these directions. The use of growth substances for specific agricultural purposes is well covered in Chapters 8–11. In all cases, the physiological aspects as well as practical applications are dealt with, though the author rightly avoids making detailed recommendations regarding concentrations, methods of application, etc. Full references, however, are given so that the interested

reader can easily follow up these aspects. Chapters 12–15 provide interesting reading and reveal many important lines of research which so far have received far from adequate attention. Thus, it still remains to be shown whether a flowering hormone actually exists, and there is much to be discovered about naturally occurring growth inhibitors. Taken as a whole, the book can be said to serve the needs of all who are interested in this field of work. Certainly, the physiological approach is useful and stimulating to the chemist, and the physiologist likewise will find the chemical treatment satisfying. Yet the book is most readable and the aim of the author to cater for the layman as well as the scientist has been quite well achieved, there being a useful glossary of technical terms for those completely new to this field of study.

The volume is well produced with excellent photographs and diagrams. Many references to original work are given, and appendixes relating to the use of specific compounds for the rooting of cuttings, the setting of fruit, weed control and for preventing the pre-harvest drop of apples are provided.

This book is the best of its kind yet published and can be confidently recommended. R. L. Wain

SEEING THROUGH THE ATMOSPHERE

Vision through the Atmosphere

By W. E. Knowles Middleton. Pp. xiv+250. (Toronto: University of Toronto Press; London: Oxford University Press, 1952.) 68*s*. net.

THIS book replaces the author's well-known earlier and smaller volume, "Visibility in Meteorology", the second edition of which appeared in 1941. It is in no sense a third edition but an entirely new book, although most of the ground covered is the same as before. The reason for the change of title is interesting. As the author points out, "To the meteorologist '*the* visibility' means a *distance*—that at which it is just possible to distinguish a dark object against the horizon. It is now fourteen years since the writer began to press for a change in this illogical terminology, and his complete lack of success is probably only an indication that language is born, not made". The book is concerned with a much wider field than 'visibility' in this restricted sense; in fact, it deals with what have been well termed the photometric properties of the atmosphere and their measurement, and with those properties of the eye which affect the visual range.

The author is at pains to drive home his thesis that the present method of estimating 'visibility' is completely out of date, since it ignores most of the great volume of work carried out by physicists and others during the Second World War. This work makes it possible to predict with remarkable accuracy the range at which a given object can be detected, provided we know certain physical quantities concerning the atmosphere, quantities which can now be readily measured with fairly simple photometric apparatus.

The underlying theory is described in detail in two chapters. These are followed by a short chapter on the eye, and then come the chapters in which all that has gone before is synthesized and in which methods are described for determining the visual range of objects seen in daylight and light sources seen at night. There is also a chapter on the colours of distant objects and the visual range of coloured objects. The last main chapter consists of descriptions, most often with diagrams, of instruments used for measuring the quantities related to visual range. Of these the chief are extinction and scatter. Many different types of telephotometers used for measuring extinction are described and criticized and then a section is devoted to instruments which measure scatter. 'Visibility meters' are not ignored.

It is gratifying to note the evident and expressed appreciation of the author for the work carried out in Britain during the War. Incidentally, as an index of the stimulus which the War supplied, it is notable that of the 420 papers listed by the author in his bibliography, nearly one-half date from 1940 onwards.

"Visibility in Meteorology" was a classic, and to say that the present volume is a worthy successor is no mean praise, but it is fully justified. The subject-matter is not easy; but the exposition is clear and the style is excellent, while here and there are welcome touches which reveal the author's sense of humour. The production is very good and the lavish use of paper such as to cause a jealous pang to many a publisher and author in Britain. A British reader may regret the use of American terms, such as 'phototube' for 'photocell', and some other unfamiliar words such as 'illuminance' for 'illumination', while on p. 7 there is the misleading statement that the International Commission on Illumination has adopted the term 'luminance factor' for both 'luminous reflectance' and 'luminous transmittance'. The very minor nature of these criticisms, however, only serves to indicate the high standard which the author has set himself and has achieved in a book which will be highly valued, not only by meteorologists, but also by others who are interested in the subject indicated by the title. John W. T. Walsh

JEAN REY'S PIONEER WORK ON OXIDATION

The Essays of Jean Rey

A facsimile reprint of the original edition of 1630. With an introduction by Dr. Douglas McKie. Pp. xliv+144+xlv–lxxxiii. (London: Edward Arnold and Co., Ltd., 1951.) 21*s*. net.

JEAN REY was a French physician, born at Le Bugue, a small town near Perigueux, in Dordogne, where he practised after graduating M.D. in the University of Montpellier in 1609. His claim to fame is that he anticipated, by some hundred and fifty years, Lavoisier's conclusion, first announced in 1774, that the increase in weight in metals on calcination is due to their combination with air. Rey, however, did not visualize combination in the sense proposed by Lavoisier and accepted to-day. His views were supported by one experiment only; but by means of this experiment he claimed, to use his own words, that "all opinions contrary to mine are utterly refuted". He discussed the effects of calcination in a little book entitled "Essays . . . sur la recerche de la cause pour laquelle l'Estain & le Plomb augmentent de poids quand on les calcine", which was printed at Bazas, near Bordeaux, in 1630. In 1775, immediately following the publication

by Lavoisier of the first of his memoirs on the theory of combustion, attention was directed to Rey's book, with the suggestion that it was perhaps unknown to the chemists of that day. Occasional references had, however, been made to it, between 1630 and 1774, in the literature of chemistry—the earliest, indeed, by no less a person than the philosopher Mersenne. A correspondence between Rey and Mersenne resulted, and this has been reproduced in this modern edition of the "Essays". Nevertheless, later references were few, a fact that Dr. D. McKie, in his introduction to the volume, suggests may perhaps be attributed to scarcity of copies of the book itself, rather than lack of appreciation of its contents. The original edition was, probably, small and intended only for circulation among the author's friends. To-day the first edition is certainly very rare, only seven copies having been traced. Since 1774 a number of reprints and translations have appeared, but these too are not now easily obtainable.

The new edition reproduces the original text in facsimile, so that scholars may now read it in the original French, and the value of this reprint is greatly enhanced by Dr. McKie's introductory essay. In addition to the few facts known about Rey's life, the introduction contains bibliographical details of the earlier editions of the "Essays" and a critical appreciation of the work itself, and such influence as it may have had on the development of chemistry.

Much of the information contained in this essay is derived from sources not easily accessible, if at all, to the average student. Readers of Dr. McKie's studies in the history of chemistry need scarcely be told that he has been at great pains to seek it out, to check its accuracy, and to assemble it in readable form. His attractively produced reprint of the "Essays" should take rank as the definitive edition, at any rate so far as English-speaking readers are concerned, and as such it will be welcomed by librarians and students of the history of chemistry.

V. A. Eyles

BIOLOGICAL PHILOSOPHY

Problems of Life

An Evaluation of Modern Biological Thought. By Ludwig von Bertalanffy. Pp. xi+216. (London: Watts and Co., Ltd., 1952.) 25*s*. net.

"THE future historian of our times," says Dr. L. von Bertalanffy towards the end of this book (p. 194), "will note as a remarkable phenomenon that since the time of [after] the First World War, similar conceptions about Nature, mind, life and society, arose independently, not only in different sciences, but also in different countries. Everywhere we find the same leading motifs; concepts of organization showing [that is, the concept of an organization which manifests] new characteristics and laws at each level, those of [that is, the concept of] the dynamic nature of [reality], and the [that of] antitheses within it". That the philosophy of organic naturalism has in general, during the past half-century, risen to the status of a dominant world outlook among men of science is, indeed, undeniable. The ideas of Whitehead, at least in their broader aspects, have been almost universally accepted; the controversy between vitalism and mechanism, which in the twenties was still flourishing, no longer attracts any attention; the *Gestalt* conception in psychology and physiology has proved itself. The problem now before scientific workers is the practical one of elucidating the relations between the 'organisms' at the atomic and molecular level, and the organic form of living things which they compose. Dr. von Bertalanffy is one of the foremost living theoretical biologists, Austrian by origin, who has been associated with the study and exposition of organic naturalism since his first publication in 1926. In recent years he has become what one might describe as 'the Woodger of Canada'.

The plan of the book begins by contrasting the conceptions of organic naturalism with the classical alternative. It then considers levels of organization, the present position of the cell theory, and the question of supra-individual organisms. This is followed by detailed exemplifications from experimental morphology and neurophysiology, after which such hypotheses as the biological magnification of non-statistical microphysical events are discussed. The work ends with the demand for a new general theory of systems, and the promise that new logico-mathematical formulations suitable for organic phenomena have been devised and will be presented in a further book (p. 199). The present monograph is highly recommendable for younger scientists who have not been able to follow, during the past three decades, the development of the points of view now generally accepted.

This is not to say that one can lay down the book without certain feelings of dissatisfaction. In the first place, the translator has failed to rise to the level of the German original, published in Switzerland in 1949. It takes a certain acuity as well as goodwill to penetrate through his English to the value within it. For example, upon a single page (p. 171) the reviewer noted the following necessary substitutions: "methodological" for "methodical", "enunciate" for "enounce", "spiritual" for "psychic", "myth or" for "mythical", and "illusory" for "illusive". The text is full of sentences of this kind: "It is the peculiar hybrid position between science and poetry by which vitalism is sapped". If the whole book could be re-written in English, its value would be doubled. Indeed, in order to quote the passage used at the beginning of this review, the reviewer had to add elucidations. There are also a few irritating mistakes, such as the eternal confusion of J. B. S. Haldane with his father (p. 197).

But a more basic criticism is that Dr. von Bertalanffy, if intending to cover the whole field of organic philosophy, ought to have done more justice to Whitehead, even if Smuts and Lloyd-Morgan were treated shortly. He may have felt that this would have been to go beyond the bounds of that theoretical biology about which he wanted to talk; but even within them, there are certain fascinating subjects, such as the relation between thermodynamic theory and biological evolution, which are scarcely touched upon. However, there are obvious limits to what can be done in two hundred pages of fairly large type; and this book should in any event take its place upon the shelves of all biological libraries, both private and public. If it reached a few physico-chemical ones also, that would be all to the good.

Joseph Needham

AUSTRIAN WOOD RESEARCH INSTITUTE, VIENNA

By Prof. JOSEF KISSER
Scientific Director

NO less than 37·4 per cent of the land surface of Austria is covered with forests—or 42 per cent with respect to the fertile areas. Austria, therefore, is not only in a position to satisfy her internal demand for timber, but also to export a considerable amount. The growing requirements of a continuously increasing population in Europe, on one hand, and the decrease in usable forests, on the other, raise the question of how the demands by the peoples for so valuable and useful a raw material can be satisfied in the future. It is therefore necessary to introduce immediately at the places of timber production measures which will make possible a greater rational output and utilization by the efficient use of the various kinds of timber, and which will effect economies and, at the same time, make the most of the timber residue by improving the existing technical processes, and by developing new methods for the mechanical and chemical processing of timber.

To deal with these many-sided problems, the Austrian Society for Wood Research was founded in 1947. The first task of this Society was to co-ordinate the endeavours of all Austrian scientific workers, both theoretical and practical, engaged on wood research and to found a scientific community. In order to overcome the problems allotted to it, the Society made use of the various facilities for research of the universities, scientific institutes and technical colleges, and generously subsidized their endeavours. In this way it became possible to arrange for numerous experiments in the field of timber research and timber utilization which proved to be of scientific and economic importance. Since many problems of timber research are, however, of a highly complex nature, and call for the closest co-operation of experts in many diverse fields, a number of scientific studies, although of great importance to the timber industry, had to be laid aside for the time being, because no success could be guaranteed owing to the fact that many scientific workers and research institutes are at a great distance from each other.

In 1950 the Forest Commission of the United Nations Food and Agriculture Organization submitted a report to the Austrian Government recommending, among other things, that a more generous subvention should be allotted to timber research, and a separate institute should be founded for it. In accordance with this recommendation, and under the special patronage of the Ministry of Commerce and Reconstruction as well as on the recommendation of the timber industry, the Austrian Wood Research Institute was founded by the Austrian Society for Wood Research, the means being contributed by the funds of the European Recovery Programme, the Viennese Chamber of Trade, and through credits guaranteed by the City of Vienna. It is housed on the grounds of the Arsenal (see Fig. 1), the address being Wien 3, Object 212 (Austria).

The main task of the Wood Research Institute is to serve the interests of the Austrian timber industry

Photo: W. Serentschy

Fig. 1. The Austrian Wood Research Institute, Vienna

and to carry out scientific experiments with the view of improving the existing processes and methods, mechanical and chemical, in the manufacture of timber, and discovering new ways of utilizing timber. Apart from *ad hoc* researches, it is, of course, indispensable that fundamental investigations should also be carried out on the inner structure, chemical composition and physical properties of wood. The various investigations undertaken by the Wood Research Institute include problems raised by the scientific members of the Institute themselves, the solution of which is of interest to the industry, the further utilization and practical testing of new developments abroad, problems of general interest put to the Institute by the timber industry and, lastly, special development processes undertaken by special contract, for the sole benefit of individual timber manufacturers. The Institute is also an important centre of information and, in a suitable manner, puts at the disposal of the Austrian economy in general new knowledge and scientific results that have been obtained in the field of wood utilization at home and abroad. The work of the Institute is based on the closest collaboration of the various technical departments and their scientific staffs, and its lay-out has been considered with special regard to these matters. Only on the basis of such team-work can each timber problem be dealt with from every relevant angle.

In order to eliminate overlapping with the work of other research organizations, the tasks of the Institute have been exactly defined. Research work starts the moment the timber leaves the forest and comprises all stages of treatment, manufacture and refinement until the finished product reaches the consumer. Indispensable collaboration with forest research is guaranteed by the fact that those concerned with forestry, especially the director of the Federal Station for Forest Research, Wien-Mariabrunn, are represented on the board of the Austrian Society for Wood Research, and are thus in a position to balance overlapping-problems against each other.

With regard to its organization, the Wood Research Institute has been divided into a number of departments and sub-departments, each with its own director and scientific and technical staff. At present it consists of the following departments: microscopy and research on wood structure; chemistry of wood and chemical technology; chemistry of paper and cellulose; pests and protection of wood; physics of wood, including tests of strength; mechanical technology of wood; fibre boards and dowels; and, lastly, wooden constructions, together with all the necessary laboratories, fittings and workshops. For reasons of expediency, the management of the Institute has been split into two and consists of a scientific director responsible for all the scientific problems and the organization of scientific research, and an economic director whose concern is the administration and the technical problems of the Institute. This solution has the great advantage that the scientific director is able to devote all his time to his true work and is never bothered by administrative and commercial questions.

After very careful planning, the Institute was opened on October 22 this year, although the erection of the buildings had only been begun during July 1952, and the importance of the occasion was emphasized by the fact that the opening was performed by the Federal Chancellor, Herr Julius Raab. The Austrian Institute of Wood Research is the first research institute in Austria to serve a whole big economic field. The opening celebrations included three lectures: the electron microscopy of wood, by Prof. A. Frey-Wyssling (Zurich); the future tasks of mechanico-technological wood research, by Prof. F. Kollmann (Reinbek, near Hamburg); and problems and the importance of lignin research, by Dr. K. Kratzl (Vienna). The scientific content of these lectures stressed the range of tasks of the Wood Research Institute, namely, the cultivation of general and fundamental research and of research in the important fields of mechanics and chemistry of wood utilization. The lectures had a double importance, however, for the fact that the speakers represented three different countries, namely, Switzerland, Germany and Austria, fully underlines the hope for a close collaboration in Middle Europe in the field of wood research.

SCIENCE AND APPLICATIONS OF PHOTOGRAPHY

CENTENARY OF THE ROYAL PHOTOGRAPHIC SOCIETY

IN celebration of its centenary, the Royal Photographic Society arranged an International Conference on the Science and Applications of Photography. The conference headquarters where nearly all the meetings were held was at the Institute of Education, University of London, and meetings lasted from September 19 until September 25. There were about five hundred members, of whom two hundred were from overseas; 161 papers were read. The proceedings were grouped into five sections, namely, *A*, photographic science; *B*, colour photography, kinematography, stereophotography, photogrammetry; *C*, technique and applications of photography; *D*, photomechanical processes; and *E*, history, literature and training in photography, photocopying techniques.

In addition to an address by the president of each section, so arranged that all members of the Conference could attend, public lectures were given in the evenings by Mr. Harold White on "Fox Talbot and His Achievements", by Dr. G. B. Harrison on "Photography in the Service of Science", by Dr. C. E. K. Mees on "Fifty Years Work on the Theory of the Photographic Process" and by Dr. Ralph Evans on "Creative Directions in Colour Photography". At the Conference Dinner, on the last evening, the Astronomer Royal, Sir Harold Spencer Jones, proposed the toast of "Photography", replied to by Dr. C. E. K. Mees.

The amount of material presented was considerable, and it is quite impossible to summarize it all in a reasonable space. The topics mentioned here, therefore, come mainly from the section dealing with the science of photography, and have been selected from those available mainly because they can be included in a fairly coherent account. The full proceedings, amounting to nearly half a million words, will be published very shortly. For this prospect the Society is indebted to Dr. R. S. Schultze, honorary secretary of the Conference. References to the papers from which material for this account has been taken are given as superscript numbers. The material between any two such numbers has been taken from the paper given under the second number.

Significance of Adsorption by Silver Halide Grains

The most prominent general feature of the contributions dealing with the theory of photography was the importance attributed to adsorption phenomena at the surface of the silver halide grains. The grains are prepared by precipitation and subsequent treatment as dispersions in gelatin solutions, in consequence of which a layer of gelatin with a thickness of about 35 A. is bound tightly on them. In order to extend the colour sensitivity of emulsions beyond the limits to which silver halides are naturally sensitive, dyes are added. These dyes are adsorbed to the grains. If a dye is not too tightly held, the adsorption isotherm often displays a break, and the absorption spectra of the adsorbed dye above and below the break may be markedly different. This is taken to indicate a change, from a 'non-co-operative' state in which dye molecules on the grain are relatively isolated, to a 'co-operative' one in which they are closely packed and exerting strong lateral interactions. In the latter state the dye molecules, which for the most part are longer and broader than they are thick, are stacked in a monomolecular layer with the molecules face to face, and on edge at a steep angle to the grain surface. The more tightly adsorbed dyes usually give adsorption isotherms approximating to the Langmuir form, and are presumably always adsorbed in the latter state, whatever the concentration of dye in the surrounding medium.

Gelatin in the dye solution hinders adsorption by the grains, slowing down the rate of adsorption and reducing the amount of dye adsorbed in equilibrium with a given solution concentration, except when the concentration is high and the grains are almost completely covered by a monomolecular layer in any case. The effect is reversible: grains dyed in weak gelatin solution and transferred to stronger gelatin solution acquire the same surface conditions as if they were dyed in the stronger solution. For one particular merocyanine dye the heats of adsorption (calculated from the temperature coefficients of adsorption) varied from 3,000 cal./mole at 7 per cent gelatin, to about 8,000 cal./mole at 0·16–0·2 per cent gelatin in the 'non-co-operative' state and about 9,500 cal./mole in the 'co-operative' state, and 12,200 cal./mole with no gelatin. On the assumption that adsorption of dye requires displacement of gelatin, the difference of 9,000 cal./mole between the highest and lowest values is presumably a measure of the heat of desorption of gelatin per dye molecule. Micro-Kjeldahl determinations of the nitrogen associated with dyed and undyed grains after centrifuging from 7 per cent gelatin solutions and washing gave direct indication of removal of gelatin on dyeing[1].

For a long time after the discovery of the colour-sensitizing action of certain dyes, those suitable for the purpose could only be selected by empirical trial. The same is still true to some extent: nevertheless, the general character which a dye must possess to be effective is becoming clear. Much the greater number of sensitizing dyes follow the general formula $A(-CH=)_n B$, where A and B represent heterocyclic nuclei, such as those of quinoline, benzothiazole, rhodanine, joined by a methine or polymethine bridge. Hydrogen atoms in the nuclei and bridge may be replaced by substituents. The nuclei themselves are planar or nearly planar in structure, and both experiment and theory suggest that they will lie in the same plane, in the most stable configuration, when linked through a conjugated chain.

If it is assumed that a dye molecule is plane, a nearer approximation to its true shape than that given by its chemical formula can be reached by making a drawing using standard van der Waals radii of the units in the formula. When all possible geometrical adjustments in position have been made and two parts of the molecule still overlap, then the dye cannot be plane. Sensitizing dyes are known of all characters in which the shape is graded from 'loose', where there is more than adequate room for the dye to take a plane form, through 'compact' where the components of the molecule are so large that a plane form is just possible, to 'crowded', where the molecule must be seriously distorted from the plane form. As a general rule, it may be taken that a 'crowded' dye is a poorer sensitizer than a 'compact' one, and that it absorbs light less strongly, though maybe only slightly so. It seems that planar dyes can arrange themselves on the silver halide grains edge-on and tightly packed more readily than crowded dyes, and that this is the disposition which leads to most effective transfer of the energy they absorb to the silver halide.

The general indications are that 'compact' dyes aggregate more readily than 'loose' dyes, as might be expected since they cannot vary appreciably from the form which they must have in the aggregated state. Poor sensitization is not, however, necessarily attributable to overcrowding. Negative substituents such as nitro- and acetyl-, introduced where they cause no crowding, usually lead to depression of sensitization, and other groupings, not negative, also have similar effects. Moreover, a dye does not need to be planar to be a good sensitizer; though the cases known suggest that the molecule must consist of a substantial planar part, groups not lying in the plane being twisted or rotated out of the plane[2].

The photoconductivity of the silver halide grains in commercial photographic materials can be measured if the strong electrolytic conductivity is balanced out. It is then found that the variations with wave-length of the light absorption, the photoconductivity and the photographic sensitivity are parallel. The energy absorbed by the dye, therefore, is made available to release electrons in the silver halide, after which point the processes leading to the creation of the latent image are identical, whether exposure is by light in the sensitizing or the non-sensitizing region of the spectrum. The absorption of sensitizing dyes in solutions frequently varies strongly with concentration, and at high concentrations many show a very strong narrow absorption band on the long wave-length side of the normal absorption. This 'J-band' is due to the formation of long aggregates like 'linear' crystals, in which 'exciton' propagation of energy occurs. Close packing of the dye molecules on the grains is favourable to 'exciton' propagation, but such propagation must not be too easy or the energy is likely to be lost in unwanted ways. Certain compounds (among which are dyes) known as supersensitizers confer added effectiveness in colour sensitization. It appears that these must be such as to fit well into the structure of the dye layer, and also to cause a local distortion of the structure at which transfer to the silver halide can occur. Other compounds act as desensitizers, so that the 'exciton' energy is

lost. When the silver halide grains are dye-sensitized there is some loss of their natural sensitivity. This may be due to loss of electrons, which have been excited into the conduction band, to the dye, where they lose their energy and cannot assist in the production of the latent image[3].

Gelatine has a strong influence on the rate of development. If silver halide grains are free of gelatine they are, with many developers, reduced to silver whether they have been exposed to light or not. In the ordinary way, differentiation between exposed and unexposed grains is extremely strong as, of course, it must be if development is to produce useful results. The rate of development is controlled substantially by two factors, namely, AT, a statistical factor, and an exponential factor, $\exp(-E/RT)$, E being an activation energy. The ratio of the rates of development of exposed and unexposed grains is then $(A'/A'')\exp(\Delta E/RT)$. The difference in activation energy ΔE estimated from the temperature coefficients of development is of the order of 6–12 kcal./mole, and is not likely to be much affected by the adsorption energies, which are probably nearly the same for exposed and unexposed grains. Developers can often exist in non-ionized and ionized forms, and the activation energy will vary with ionization. If the developing agent is ionized, the factor A will also be influenced by the charge on the silver halide grain. This is negative in ordinary photographic emulsions, and, judging from the zeta-potential, imposes a barrier of the order of 50 mV. Negatively charged ions are subjected to repulsion, and only a fraction of them will have sufficient energy to penetrate the barrier, the fraction decreasing by an order of magnitude as the ionic charge increases by one electron. The rate of development should therefore be increased if the charge barrier were eliminated. This expectation was borne out by tests in which photographic material was bathed in an active quaternary salt, which reduces and possibly eliminates the charge barrier. These considerations neglect adsorption, but it has been shown that developing agents do adsorb to silver halide, for some dyes, adsorbed to silver halide, are displaced by developing agents. This is not always so, for if the dye and developer are in ionic form and of opposite sign, the developer may be adsorbed and bind the dye still more tightly to the silver halide[4].

Surface-active cationic substances which reduce the charge barrier at the surface of silver bromide crystals in emulsion can also lead to increases in rate of fixation by thiosulphate. The accelerating effect decreases as the concentration of thiosulphate is increased, and displays a maximum in relation to the concentration of surface-active agent[5].

The rate of development of metol when used alone is slow, and of hydroquinone, slower still. Together they develop rapidly. Two hypotheses have been put forward to account for this phenomenon of 'super-additivity'. One suggests that metol oxidized during the process of development is reduced to its original form by hydroquinone, the other that the low activity of hydroquinone arises because it is strongly ionized and cannot penetrate the charge barrier on the surface of the silver halide, but can do so if an intermediate product in the oxidation of metol is adsorbed to the silver halides. A new developer, 1-phenyl-3-pyrazolidone, behaves in a similar way to metol and in this case the formation of an intermediate when it is used alone is revealed by its red colour. The presence of hydroquinone prevents the formation of the red colour. Thus, the regeneration hypothesis seems likely to be sound, and indeed, other evidence strongly favours it. Nevertheless, some of the experiments described also suggest that the charge barrier is reduced so that hydroquinone also may take part in development in the mixed developer[6,7].

It has been shown that silver ions are adsorbed to silica or glass when hydroxyl ions are present, and that the material so produced is photosensitive. In silver bromide sols, silver ions are adsorbed from acid solution. If then the hydroxyl ion concentration is raised, the sol becomes more sensitive to light. This is probably due to the formation of a silver–hydroxyl complex on the surface of the silver halide. At high solution concentrations of hydroxyl ions, the number of hydroxyl ions adsorbed was found to be about one-fifth of the number of available ion-sites on the surface of the silver bromide. As this complex is photosensitive, it appears that two photolytic processes are possible, and may both occur in ordinary photographic materials: namely, transfer of an electron from the lattice of silver bromide to a surface silver ion, and transfer of an electron from the silver–hydroxyl complex. Silver bromide sols, with no gelatin, are further sensitized by allyl thiourea, when it is adsorbed without breakdown to the silver bromide crystals. The H. and D. curve then displays two parts: first a slow rise of opacity with increasing exposure, and then a very rapid rise. The first of these is attributed to the silver–hydroxyl complex, and the second to the silver halide crystal itself. Confirmation of this hypothesis is provided by the difference in colour sensitivity of the two regions of the curve[8,9].

The importance of the conditions at the surface of silver bromide crystals has been underlined by experimental results on large thin crystals. Previous work showed that such crystals were sensitized by very thin deposits of silver, gold and metallic sulphides. In further experiments, crystals sensitized in the above ways were dipped in inert gelatin solution adjusted in silver ion and hydroxyl ion concentration, drained and dried. The gelatin improves the stability of the sensitizing layers, decreases the fog and adds to the sensitivity, the additional sensitivity being greater the higher the hydroxyl ion concentration, and somewhat greater the higher the silver ion concentration. A similar kind of result is obtained when the crystal has not been sensitized beforehand. The sensitization by gelatin is much greater if the crystal is digested in warm gelatin solution for periods up to half an hour. The gelatin film was found to be detachable by re-immersion in gelatin solution. When it settled back on the crystal so as to cover a part of the crystal not previously covered, the sensitization was transferred with the gelatin.

Sensitization was found to be accelerated by known sensitizers of the reducing types, gold salts, and thiosulphate and substituted thioureas. Products of the sensitizing process are formed in the gelatin adjacent to the crystal surface, and on the crystal surface itself, those on the latter probably consisting of aggregates of silver, gold, silver oxide or silver sulphide. Of the two, the products in the gelatin layer are the more effective as sensitizers.

It has always been difficult to account for the apparent lack of recombination of positive holes (roughly speaking, bromine atoms left by electrons

which have been raised to the conduction bands) and electrons in the Gurney–Mott theory of the latent image. The above experimental results lead to the suggestion that the function of the chemical sensitizer is to trap the positive holes created during exposure to light. The crystals formed during the preparation of photographic emulsions are supposed to consist of polyhedral blocks, slightly misaligned, the boundaries of which constitute severe local dislocations. These dislocations persist out to the surface, where they provide a region for localized separation of silver—the surface latent image. The internal dislocations can also provide sites for internal latent image[10].

The above description does not require the supposition that gelatin is occluded within the grains, which has been put forward to account for the existence of internal latent image. The supposition is unlikely to be true. If gelatin is completely removed from the surface of grains (by bathing in hypobromite solution), the internal gelatin, if any, can be released by dissolving the grains in thiosulphate and brought to a higher concentration by foaming. A modified Zsigmondy gold number test then shows that the average gelatin content is certainly less than one gelatin molecule to six grains. Many more than one-sixth of the grains can carry internal latent image. Thus, occlusion of gelatin is unlikely, and in any event not a necessary condition for the production of internal latent image[11].

The general tenor of the work so far described, therefore, has been to emphasize the importance of the conditions at the surface of grains, and, in considering how the latent image is produced, to pay at least as much attention to the mode of disposal of the bromine (the positive hole in the crystal lattice) as to the production of development centres by aggregation of metallic silver. The theory of latent image has returned part way to the old hypothesis that silver bromide grains become developable as a result of formation of sub-halides by the escape of bromine[12].

Some Chemical Aspects

Bromine and chromic acid solutions applied to photographic materials will make them less sensitive or, if applied after exposure, reduce the latent image capable of being developed. It was suggested that desensitization of weak sensitivity centres (that is, those requiring heavy exposure to convert to latent image) is a consequence of adsorption of bromine or chromate ions. Sensitivity centres more easily converted to latent image behave more like weak latent image, while strong latent image is oxidized[13]. The results may be taken as suggesting that weak sensitivity centres are special locations where silver is formed as a result of exposure; stronger centres already contain some silver, and true latent image requires a certain minimum amount of silver. This would be consistent with results of tests of various kinds on the fog produced by heavy sensitizing treatment. When sensitized by reduction (with stannous chloride) the fog has the properties of metallic silver; but when sensitized by sulphur-containing gelatin, its properties are more nearly those of silver sulphide[14].

It has long been known that sharp-edged, and especially contrasty, details in photographs are affected by diffusion of the developer and its reaction products. In black-and-white photography this causes distortions of tone-reproduction and even makes the photograph of a detail different in geometry from the original image. In modern processes of colour photography, which use three layers of emulsion, differently colour-sensitized and, in the final result, differently coloured, any one of the three layers may be affected by the development processes in the other two. The results seem to be fortunate: in most cases the colour quality is improved[15]. A yellow filter layer is necessary in colour films to eliminate blue light remaining after the top blue-sensitive layer has been exposed. This is usually of colloidal silver, the particles of which accelerate the reduction of silver salts produced during development. In this way a colour fog is produced. It was by a study of this phenomenon in a commercial colour process that a specially rapid process was worked out for the production of copies of documents. In this process the unexposed silver salts of a negative emulsion are made to produce a positive silver image in a second emulsion in contact with it[16].

Physics of the Developed Image

There is still much interest in the capacity of photographic materials for reproducing detail, which justifies leaving aside the main topic of surface phenomena and mentioning something about what is commonly called the physics of the developed image. The capacity of a photographic material to record fine detail is limited by the diffusion of light in the sensitive layer and the heterogeneity known as granularity or graininess. The best description of the light scattering is the light distribution in the neighbourhood of a vanishingly small, brightly illuminated spot. This is difficult to measure experimentally, and it is customary to throw a thin line of light on the sensitive layer and measure the light distribution thereby produced. The fall of intensity each side of the line is exponential. If an arbitrary function is assumed for the light distribution around a point, integrated to give the distribution for a line, and the integral equated to the exponential distribution observed, the nature of the arbitrary function may be completely determined, and it is then available for calculating the light distribution in other forms of image. Experimental tests are in as good agreement as can be expected, considering the difficulties of the measurements[17]. The amount of diffusion increases with thickness of the layer, but less so when the exposure is with light of short wave-length, owing to the stronger absorption.

In measurements of resolving power the aperture of the lens used to project the test image is important. If the aperture is low, the resolving power of the lens is limited; if the aperture is considerable, some of the image is out of focus by reason of the thickness of the sensitive layer, and this limits the resolving power. Consequently, maximum resolving power is observed at a medium aperture[18]. In autoradiography the resolving power is largely dependent on the thickness of the emulsion layer, and also on the thickness of the specimen and intimacy of contact[19].

The measurement of resolving power in radiographs is somewhat difficult because the preparation of suitable test objects is difficult. It has been found, however, that a mercury physical developer, to intensify the silver image, is capable of giving a deposit of mercury, in a photographic test object of a customary pattern, sufficiently opaque to X-rays to make satisfactory test objects for the purpose[20]. An interesting point is that colour photographs often

appear sharper than black-and-white photographs with the same resolving power. Experiments were reported which indicate that the judgment of sharpness depends upon the saturation of the colours and the structure of the photograph[21].

[1] West, W., Carroll, B. H., and Whitcomb, D. L., "Some effects of gelatin on the adsorption of sensitizing dyes on the silver halide grain surfaces".

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TOXIC HAZARDS OF PESTICIDES TO MAN

FROM the time of his first appearance on this earth, man has been engaged in mortal combat by insects and other types of vermin. Through all the centuries of recorded time men have been plagued by insects, and literally millions have died of insect-borne diseases or of starvation, often induced by loss of crops directly attributable to various types of pests. Insect-borne diseases rank high, if not foremost, among the great public-health hazards of the world. For centuries yellow fever, malaria, plague, typhoid and dysentery, to mention only a few well-known examples, have brought misery and death to millions of humans, determined the outcome of wars, and in no small way affected the course of history.

Likewise, in the agricultural sphere insects, plant diseases, weeds, rodents and other pests exact an almost unbelievably heavy toll on all agricultural production. Estimates of crop-losses due to these pests may vary from as low as 10 to as high as 50 per cent of all agricultural production. While there is a paucity of statistically sound data to support any such estimates, it seems safe to assume that the tribute demanded and taken by pests is at least a quarter to a third of the world's agricultural output.

In days gone by, as more and more food was needed to feed an ever-increasing population, nations one after another sought to colonize new lands and thereby expand food production; but the door to this avenue of escape is practically closed. Now that there are no new lands to conquer, man shows signs of acquiring some sense with regard to developing a sound agricultural programme. Such a programme must abandon the age-old practice of exploiting—or as we say in the United States, 'mining' our fertile soils—and must provide for the adoption of sound scientific procedures, not the least of which is practical pest control.

Science has developed ways and means of combating most of the vectors of insect-borne diseases and many of the more important crop pests; but, unfortunately, in most cases the actual control of these pests involves the use of one or more of the rather toxic chemicals which may be objectionable from certain points of view.

Any attempt to evaluate such hazards as may be inherent in the use of pesticides should be predicated upon a rather thorough understanding of a few of the more-or-less axiomatic principles involved: (1) Practically all pesticides have toxic properties and are toxic to warm-blooded animals, including man, as well as to insects. If they did not have these properties, they probably would not control pests and therefore would not be good pesticides. (2) The fact that most pesticides are toxic to man and animals does not necessarily mean that they cannot be used safely. If one develops a proper respect for the toxic properties of a substance, it may frequently be used with greater safety than a much less toxic substance which is apt to be handled carelessly. (3) A careful distinction must be drawn between the terms 'hazard' and 'toxicity'. Toxicity is the capacity of a substance to produce injury, and hazard is the probability that injury will result from the use of the substance in the quantity and in the manner proposed. To be at all reliable, any estimate of the hazard involved in the use of a substance must be based not only upon a knowledge of its inherent toxicity, but also upon the details of its proposed use, as well. (4) To avoid hopeless confusion, one must distinguish between use or operation hazards, and residue or food contamination hazards.

Most individuals interested in the hazards associated with pesticide usage have read some of the charges brought against pesticides, and at least some of the arguments advanced in their defence. Obviously, the problems encountered in the introduction of new chemicals are not unique. In common with many other advances in science and technology, pesticides must be regarded with mixed feeling, in that on one hand they possess highly desirable and at times almost miraculous properties for good and, on the other hand, definite objectionable or undesirable characteristics capable of producing harm. The problem is so to balance these attributes and so to control the use of these chemicals as to secure the maximum benefit and the minimum harm. In no case should public policy be totally regulated or guided by either the optimist who sees only the Utopian pesticidal properties, or by the pessimist who sees only the most dismal potentialities for wanton destruction.

We must strive for an objective point of view wherein good and bad, desirable and undesirable, potential benefits and harm, will be brought into proper perspective and balanced one against the other. In so doing, let us recall that fire is at one and the same time man's greatest servant and

potential destroyer. Let us be mindful that the automobile, now regarded as a necessity in daily living, is one of the greatest causes of accidents, maiming and killing thousands each year, to say nothing of causing extensive property damage, destruction of wild-life, and the pollution of the atmosphere with undesirable gases. Let us recall that most of the drugs and pharmaceuticals developed to ease pain, control or suppress numerous illnesses, and lengthen human life are, when improperly used, poisonous to the extent that they must be classified among the more toxic and dangerous of the chemicals known to man.

The real problem is basically one of education. Able scientists make available to us the basic attributes of most of these new chemicals in advance of their release. Every interested individual has both legal and moral responsibilities which should regulate his actions with regard to promoting the use of pesticides. Those who develop and those who test such new materials share a responsibility for the evaluation of their beneficial and harmful properties, and for making this information available to the public. Those who distribute such materials and/or make recommendations for their use should relay this information in full, emphasizing the harmful as well as the desirable properties. Those who apply and utilize the materials have the final and perhaps the greatest responsibility. Pesticides are made available to the public on the premise that they will be used in good faith and in accord with prescribed recommendations and precautions. It has been said a chain is no stronger than its weakest link; and thus in the last analysis, all the rules and laws that might be imposed to regulate the use of pesticides will be to no avail if the ultimate user does not recognize and fulfil his responsibility for using such materials only in accord with the recommendations prescribed by the manufacturer and/or the duly authorized officials of government agencies. If the ultimate user of pesticides does not at all times recognize that the inherent rights of his neighbour and fellow man must supersede any and all personal or selfish desires, no amount of legislation will correct such an evil.

The various hazards presumably associated with the use of pesticides have been the subject of public hearings, legislative investigations, and numerous formal and informal discussions. Few problems affecting public health and national welfare have received more widespread attention or provoked greater controversy. Unfortunately, in far too many instances the voices of prejudice and the fears and apprehensions expressed by learned scientists, who have ventured opinions in fields where they were not qualified to speak with authority, have been publicized as much as or more than the cold, hard data and scientific facts presented by competent scientists, all of whom are specialists in fields of endeavour related to pesticide use. This is particularly true of sections of the Press which tend to favour sensationalism.

As the controversy grows more heated and expressed opinions become more emphatic, a large segment of the public becomes confused and bewildered by the seemingly endless flow of contradictory statements, half-truths, and in some instances malicious misrepresentation. At this point the old adage, "A little knowledge is a dangerous thing", assumes a new significance. The timely appearance of a very excellent report, "Toxic Hazards of Pesticides to Man"*, prepared under the auspices of the World Health Organization by Dr. J. M. Barnes, should do much to stabilize thinking and consolidate public opinion on this controversial subject. In a very enviable style and manner, the author has clearly and concisely set forth an unbiased evaluation of the hazards associated with pesticide usage and has pinpointed each of the many ramifications of the whole complex problem. Lest there be those who might under-estimate the true value of this report, it should be noted that the author travelled extensively, studying conditions and conferring with experts in many fields of endeavour in ten countries, corresponded with authorities in other parts of the world and reviewed a selection of more than six hundred publications bearing on all phases of the subject at hand before undertaking the task of preparing his report.

The desirability—if not indeed the necessity—for using pesticides to control the insect vectors of disease and to control pests on growing crops and produce is clearly set forth in a manner that should be entirely acceptable to all concerned. It is doubtful if any entomologist, plant pathologist, chemist, farmer, or pesticide manufacturer will or can take any serious exception to the arguments advanced or the conclusions reached: "There can be no doubt that pesticides have proved of great value both in the control of insect-borne diseases of man and in the protection of his crops. Their use will probably expand at least for a number of years in the absence of better methods for controlling the pests against which they are directed. New chemicals are expected to appear but are likely to be submitted to increasingly rigorous experimental testing before they can supersede those in use today".

The operational or occupational hazards, both real and imaginary, encountered in the manufacture of primary active ingredients, formulation into preparations suitable for field-use, handling and application are clearly set forth, as are the various hazards that might be encountered by innocent bystanders or third parties, including neighbours, trespassers, agricultural workers, and the consumers of food that might contain traces of pesticides. The general trend of these discussions is perhaps well portrayed in two brief quotations:

"In the light of existing knowledge, the policy with regard to residues in food should be one of enlightened caution. The advantages of using the pesticide as represented by improvement in the nutrition of a population must be set against the hypothetical risks incurred. Definite rulings on these questions must await the slowly developing knowledge of how these chemicals act on the living body. Meanwhile, it is well to consider how residue hazards may be reduced by means of proper controls."

"There is a possible risk to health from the ingestion of small quantities of pesticides in food, but there is no evidence that anyone has suffered illness from this cause. Difficulties in assessing this hazard exist, but control would be relatively simple provided that suitable methods of analysis were available."

It is significant that, like Drs. Hayes, Princi and other American toxicologists, Dr. Barnes repeatedly points out that the final answers to many perplexing

* World Health Organization. Monograph Series No. 16: Toxic Hazards of Certain Pesticides to Man, together with a Select Bibliography on the Toxicity of Pesticides in Man and Mammals. By J. M. Barnes. Pp. 129. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 7s. 6d.; 1.50 dollars; 480 French francs; 6 Swiss francs.

questions must in the last analysis be based upon human experience; or in his own words ". . . a closer study of man himself . . .", and can never be obtained from animal experiments alone. Certainly our problems are far from completely solved and, recognizing this fact, Dr. Barnes has made some very appropriate suggestions and recommendations for further research, justifiably stressing the need for a more complete and thorough study of human experiences.

There is always danger in the use of quotations taken out of context; but perhaps a few selected statements from the author's conclusions will serve to illustrate his point of view:

"None of the materials in use today is so inherently poisonous that its safe use is impracticable. . . . Some of the materials in use today are capable of producing severe and fatal poisoning if handled carelessly in the factory or during application. . . . Other materials are unlikely to produce acute or fatal poisoning, but because of their stability and persistence may remain in food and be consumed in small quantities over many years by the general public. Much anxiety has been expressed on this score, and it is certainly desirable that food should not contain foreign chemicals lacking any nutritive or beneficial value to man. Nevertheless, there is no evidence whatsoever that the ingestion of these materials in this way has produced undesirable reactions."

It is noteworthy that the conclusions reached in this paper are in very close general agreement with those released from time to time by the Food Protection Committee of the National Research Council in the United States.

The report also contains sections on "The Toxic Properties of Some Pesticides", "Control of Agricultural Pesticides in Different Countries", "Glossary of Names of Pesticides Used in the Text", and a bibliography of 689 titles.

As a parting word, Dr. Barnes's paper should be considered as essential for all who are in any way interested in problems associated with the use of pesticides. In a sense, this report is destined to become the Old Testament for a new but rapidly developing school of thought and philosophy.

GEORGE C. DECKER

OBITUARIES

Dr. L. F. Richardson, F.R.S.

LEWIS FRY RICHARDSON, author, in 1922, of "Weather Prediction by Numerical Process" and, in 1939, of "Generalised Foreign Politics", died at his home at Kilmun, Argyllshire, on September 30. These mentally adventurous works stamp the man, and of him it may be truly said, as Wordsworth said of Newton:

". . . a mind for ever
Voyaging through strange seas of Thought, alone."

For it was given to Richardson to be way out ahead of his contemporaries in the effort to mould experience to scientific form. Some have now caught up, or are catching up, with the meteorological research which Richardson did thirty years ago; the fate of his pioneering efforts to form a science of international relations will perhaps not be known for a still longer time.

Richardson was born into a Quaker family in Newcastle in 1881. He was educated at Bootham School, the Durham College of Science at Newcastle, and at King's College, Cambridge, where he graduated in the Natural Sciences Tripos in 1903. He was three years at the National Physical Laboratory and three in the electrical industry before reaching meteorology. In 1913 he was appointed superintendent of Eskdalemuir Geophysical Observatory, and on leaving in 1916, to join the Friends Ambulance Unit in France, he had already completed the first draft of his work on weather prediction by numerical process. Here, on the hydrodynamical and thermodynamical equation of meteorology, he brought to bear a technique of arithmetical solution of partial differential equations by finite-difference methods on which he had written at length in a paper in the *Philosophical Transactions* in 1910. Richardson returned to the Meteorological Office in 1919 to work with the late W. H. Dines, and he then completed his great volume on the evolution of weather. Electronic computers could scarcely then be dreamed of, and Richardson had other dreams of how the job might be tackled, with tier upon tier of human computers fitted into an Albert Hall structure. His methods remained undeveloped for a long period, not merely because of the magnitude of the computing problem but also through lack of an adequate three-dimensional network of observing points in the atmosphere. Moreover, as we know to-day, Richardson's equations were not well adapted to the problem in some fundamental respects—they were too general. But a mighty vision had been displayed.

Richardson's other meteorological work sprang almost directly from his analysis of the weather prediction problem. He saw that, of the processes formally expressed in his equations, least was known and understood about the transformations of radiation in the atmosphere and about atmospheric turbulence. Observational studies of the former, in relation particularly to cloud and ground surfaces, went forward with hard theorizing about the latter. In 1920 he wrote a famous paper, "The Supply of Energy from and to Atmospheric Eddies", in which by thermodynamical reasoning he sought to show that the growth or decay of turbulence in a statically stable atmosphere depended primarily on the vertical flux of heat in relation to the vertical shear of wind. The analysis threw up a non-dimensional parameter involving these quantities, and now called 'Richardson's Number', which serves to correlate phenomena affected by atmospheric turbulence much as Reynolds's number provides a correlating parameter for isothermal flow in pipes, channels and around solid bodies. In 1926 he put forward an entirely new basis for the discussion of turbulence phenomena, aimed at that time at dealing particularly with a medium such as the atmosphere in which the turbulence spectrum extends indefinitely out to larger and larger wave-lengths. He showed that the laws of diffusion in such a medium could most soundly be arrived at not, as in earlier work, by the study of the scatter of individual particles, but through the variation in separation of pairs of particles—the separation at any instant defining the scale of eddy motion effective in changing the separation. His approach is essentially that developed much more recently by Kolmogoroff and others in the now lively development of a theory of turbulence. Richardson found from observations over a tremendously wide range of scale of motions that the coefficient of

diffusion (in earlier nomenclature) increased as the four-thirds power of the scale of the diffusion process. This same 'law' has been inferred by Von Weizsäcker, Heisenberg and others from current theory, and Richardson's last hydrodynamical paper, in 1952, was a return to this field of study.

Richardson's association with the Meteorological Office ended in 1920 when it became a department of the Air Ministry and he felt compelled to resign on grounds of conscience. He became head of the Physics Department at Westminster Training College and, in 1929, principal of the Paisley Technical College. His interest shifted in the late '20s and the '30s to international relations and the psychological factors leading to war, and to this end he equipped himself in 1929, when nearly fifty years of age, with a degree in psychology. He retired from Paisley in 1940 in order to prosecute this study more fully, and the results are largely contained, in microfilm form, in a revised edition of his 1939 volume on "Generalised Foreign Politics".

Richardson was honorary secretary of the Royal Meteorological Society during 1921–24, a D.Sc. of the University of London and was elected Fellow of the Royal Society in 1926. He was a patient and original teacher, delighting in ingenious practical demonstrations with simple apparatus. His writings were utterly individual in style and highly entertaining; but few concessions were made to the reader. A fellow undergraduate at King's College said of him, "Lewis was a rock and flew his colours with superb, audacious gallantry". The audaciousness became with the years an understanding gentleness, but the superb gallantry increased. He married Dorothy, daughter of the late Dr. William Garnett, by whom he is survived with their two sons and daughter.

P. A. Sheppard

Prof. E. Bataillon

Eugène Bataillon died on November 1 at the age of eighty-nine. He started his scientific career in the Faculty of Sciences at Lyons, his first publication on amphibian embryology appearing in 1888. Afterwards he became professor of zoology at Dijon and, after 1918, professor in the University of Strasbourg. Later he became professor of zoology in the University of Montpellier, where he remained until he retired in 1932. He was a member of the Paris Academy of Sciences and received a number of prizes, including the Prix Osiris.

Bataillon covered a wide field of experimental cytology, including studies on the parthenogenetic activation of amphibian, lamprey and fish eggs, on morphogenesis and evolution, on the effect of heat on the gametes of the frog, on interspecific and intergeneric fertilization, on polyspermy and on the electrical properties of unfertilized, activated and fertilized frog eggs; but he became world-famous through his discovery that the unfertilized egg of the frog could be induced to develop parthenogenetically by puncture with a fine glass or metal needle. Bataillon found that this treatment was more successful when the needle was contaminated with blood or other foreign bodies. What is the nature of the stimulus exerted by these contaminating materials? Are they thromboplastic or must they contain nucleoproteins? This is a problem which is just as interesting to-day as it was when Bataillon first formulated it at the beginning of this century.

In a famous paper on traumatic parthenogenetic activation, published in 1910 [1], Bataillon said: "Cette parthénogenèse effective chez un vertébré était, pour moi, un résultat inespéré. L'élevage des larves étant *en général* facile, un chercheur bien installé pourra peut-être aborder sur ce matériel la solution de problèmes fondamentaux"—a prediction which was confirmed by Loeb and Bancroft [2] when they announced in 1913 that a parthenogenetic frog, obtained by Bataillon's method, was a female. Bataillon went on to say: ". . . ce n'est pas au hasard que ces expériences ont été faites". I think Bataillon was stimulated to do these experiments by the belief that spermatozoa puncture or bore through the egg surface at fertilization. To-day we do not believe that this is the case and consider, rightly or wrongly, that after enzymes from the head of the spermatozoon have softened up the egg surface, the egg engulfs the spermatozoon, as in phagocytosis.

Whatever the reasons that prompted Bataillon to carry out his experiments, they remain some of the most exciting and important in cell physiology. Many experiments still remain to be done using the elegant technique he discovered nearly fifty years ago.

Rothschild

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NEWS and VIEWS

Cavendish Chair in Cambridge: Prof. N. F. Mott, F.R.S.

Prof. N. F. Mott, Henry Overton Wills professor of physics in the University of Bristol, has been appointed Cavendish professor of experimental physics in the University of Cambridge in succession to Sir Lawrence Bragg, who is going to the Royal Institution (see *Nature*, May 9, p. 819). The departure of Prof. Mott from Bristol next autumn will end twenty-one years service to its University. Succeeding Sir John Lennard-Jones as professor of theoretical physics in 1933, he chose to take up fields of inquiry new to him, but suited to facilities in men and equipment available in the Wills Laboratory. Soon contributing to the theory of metals and alloys through his standard treatise with H. Jones, he was then led to the study of electronic processes in crystals with special reference to semiconductors, insulators and the photographic latent image. Since the Second World War he has been particularly concerned with the mechanical properties of the solid state. His work in all these fields has been marked by a flair not only for initiating and stimulating theoretical work, but also for guiding experimenters into new and exciting fields of laboratory study. Moreover, by organizing successful conferences and summer schools in the Wills Laboratory, he has done much to promote a wider interest in these subjects throughout the country. As a leader of a combined team of theorists and experimenters with a common purpose, he has no superior. When he succeeded Prof. A. M. Tyndall as director of the Wills Laboratory in 1948, Prof. Mott met his increased administrative

responsibilities with equal facility. Indeed, his loss will be felt not only in the Wills Laboratory itself, but also by his colleagues in the faculty, and by others who, concerned with the future policy of a vigorous young University, have learnt to value his counsel and judgment.

President Eisenhower's Proposals for the International Control of Atomic Energy

In his speech to the General Assembly of the United Nations at New York on December 8, President Eisenhower said that the United States are prepared immediately to meet privately with such other nations as may be "principally involved" to seek "an acceptable solution" to the atomic armaments race. They would seek more than the mere reduction or elimination of atomic materials available for military purposes. The possibility of power from atomic energy for economic purposes is already proved, and President Eisenhower proposed that the Governments principally involved, to the extent permitted to common prudence, should begin and continue to make joint contributions from their stock-piles of normal uranium and fissionable materials to an international atomic energy agency to be set up under the ægis of the United Nations. This agency would be responsible for impounding, storing and protecting the contributed fissionable and other material and for devising methods of allocating the material for peaceful purposes; and the United States are prepared to undertake such explorations in good faith and to further the development of plans for expediting the use of atomic energy for peaceful purposes.

The President indicated that he is prepared to submit to the United States Congress, with every expectation of approval, plans which would encourage world-wide investigation into the most effective peace-time uses of fissionable material and which would begin to diminish the potential destructive power of the world's atomic stock-piles. Such plans should also demonstrate to peoples of all nations that the great Powers of the world, both of the East and of the West, are interested in human aspirations first and foremost, rather than in building up armaments of war; and they should open up a new channel for peaceful discussions and initiate at least a new approach to the many difficult problems that must be solved if the world is to shake off the inertia imposed by war and to progress towards peace. In his speech the President also revealed that since July 16, 1945, the United States have conducted forty-three atomic test explosions and said that atomic bombs to-day are more than twenty-five times as powerful as the weapons with which the atomic age dawned.

Trans-Atlantic Telephone Cable

An important step forward in the development of telephone communication between Great Britain and North America occurred on December 1, when an agreement was signed in London between the General Post Office, the American Telephone and Telegraph Co., the Canadian Overseas Telecommunication Corporation and the Eastern Telephone and Telegraph Co. of Canada, for the provision of the first trans-Atlantic telephone cable, as distinct from the existing telegraph cables. The installation, which is estimated to cost £12¼ million, is likely to be ready in 1956 and will mark the completion of some twenty-five years of development in Britain and the United States. Two coaxial cables will be laid by H.M. Cable Ship *Monarch* from Oban in Scotland to Newfoundland, a distance of 2,250 miles, and these will be connected to a shorter section of coaxial cable from Newfoundland to Nova Scotia, about 360 miles in length. The former will be equipped with fifty one-way amplifying repeater units placed at 40-mile intervals, of an American type which has been adequately tested in deep water. A British type of two-way repeater will be incorporated in the single cable in Canadian waters, based on the experience of the British Post Office in the use of a similar cable during the past ten years between Anglesey and the Isle of Man, and for a shorter period between England and Holland and Denmark. When completed, the new cable should provide about twenty-nine telephone circuits between the United Kingdom and North America in place of, or in addition to, the twelve radio-telephone circuits, which are at times subject to deterioration or interruption due to fading and atmospheric disturbances. In addition, improved telegraph and telephone services to Australia and New Zealand will result from the direct wire connexion between London and Vancouver, from which point the radio service southwards is frequently superior to that across the Atlantic in the east–west direction.

Recording the Coronation: London–Montreal Joint Discussion by Radio

On December 3 the Institution of Electrical Engineers held a joint meeting with the Engineering Institute of Canada by means of a radio-telephone connexion between London and Montreal. After an exchange of greetings between the presidents of the two bodies, Mr. H. Bishop in London and Mr. R. L. Dobbin in Montreal, a paper entitled "Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on 2nd June, 1953", by W. S. Proctor, M. J. L. Pulling and F. Williams, was read in the Institution building in London. This paper described the many special and technical arrangements made for the largest outside broadcast ever undertaken by the British Broadcasting Corporation and the Post Office; the main details for broadcasting the Coronation by sound and television, and the special arrangements for getting pictures to North America, have already been summarized in *Nature* (171, 1050; 1953). A joint trans-Atlantic discussion followed the reading of the paper, in which Mr. J. E. Hayes, of the Canadian Broadcasting Corporation, and Dr. A. C. Don, Dean of Westminster, participated. After final remarks by the respective presidents on the success of the joint meeting, the technical discussions were continued independently in the two countries. In the lecture theatre in London, short extracts were shown of the B.B.C. telefilms of the actual crowning ceremony in Westminster Abbey. One of these was made by the suppressed frame system recently used by the B.B.C., while the other had been taken on the 'Mechau' camera installation, in which the vertical scanning process is effected by continuous motion of the film through the camera.

University of Nottingham

The Council of the University of Nottingham has accepted from Mr. C. T. Cripps, chairman and managing director of Pianoforte Supplies, Ltd., Simplex Works, Roade, Northampton, a gift of £100,000 for the endowment of two professorial

chairs, a Cripps chair of metallurgy and a Cripps chair of production engineering. Pianoforte Supplies, Ltd., was founded by Mr. Cripps to produce components for the music industry. While still retaining the same trading title, the firm, under his guidance and direction, has progressed into full-scale production engineering, supplying numerous different industries with metal components in all kinds of finishes. The gift is the result of an appeal by the University to industry in the Midlands for support in its schemes for engineering studies and research. It is intended that an appointment to the Cripps chair of metallurgy should be made for the session beginning in October 1954, when a degree course in metallurgy will be instituted as had already been planned. The Senate had previously given approval in principle to a proposed degree course in production engineering, but the date from which the chair will be established will now be a matter for consideration by the University Council.

Dr. K. R. Ramanathan

In commemoration of the sixtieth birthday of Dr. K. R. Ramanathan, the February number of the *Proceedings of the Indian Academy of Sciences* (**37**, A, 167 ; 1953) contains a photograph of Dr. Ramanathan as frontispiece, an appreciation by Sir C. V. Raman, a bibliography of Dr. Ramanathan's scientific contributions, and seventeen papers mainly on meteorological subjects specially contributed by eminent meteorologists from India and other countries. Sir C. V. Raman gives a summary of Dr. Ramanathan's career and refers to the high position attained by him as a man of science, to his notable contributions in various fields of knowledge and to the leading part he has played in the development of an Indian school of meteorology. After a brief period as lecturer and research worker in physics, Dr. Ramanathan in 1925 became a government meteorologist and afterwards held posts as director of Agra Observatory, the Colaba and Alibag Observatories at Bombay, the Solar Physics Observatory at Kodaikanal, superintendent meteorologist at Poona and officer on special duty at Delhi. In February 1948, following his retirement from government service, he joined the physical research laboratory at Ahmedabad and is now actively engaged on investigations of the physics of the upper atmosphere. Dr. Ramanathan is a Foundation Fellow of the Indian Academy of Sciences and has served continuously for fifteen years as a member of its Council, in addition to being a vice-president during 1943–46. He was recently elected president of the International Meteorological Association. The selected list of Dr. Ramanathan's publications shows that his interests have covered terrestrial magnetism, seismology, meteorological optics and acoustics, but his outstanding contributions are in the field of study of the thermal structure and movements of the upper air. His earliest scientific paper was a letter in *Nature* (**118**, 337 ; 1926) dealing with the intensity and polarization of skylight at sunrise and sunset, and his latest, in the commemorative issue, deals with the height distribution of atmospheric ozone.

Materials available from the Radiochemical Centre, Amersham

The Radiochemical Centre, Amersham, Bucks, has prepared a new catalogue, entitled "Radioactive Materials", which describes the products of the Centre. The catalogue, which was first issued in connexion with the International Congress of Radiology held in Copenhagen during July 20–25, will be of interest to a wide range of users in the natural sciences, medicine and engineering. About six hundred radioactive appliances and compounds that are made at Amersham are listed, including a number of important materials which are new and have not previously been available in any country. They are dealt with under the separate headings of labelled compounds (carbon-14 and miscellaneous chemical compounds containing radioactive isotopes) ; processed radioisotopes, made by chemical separation from materials irradiated in a pile or cyclotron, or from fission products ; natural radioelements ; alpha- and beta-ray appliances consisting of foils, plates and wires which incorporate a radioactive isotope ; gamma-ray appliances containing radium for therapeutic purposes ; gamma-ray sources for radiation standards or industrial radiography ; and neutron sources. Among the labelled compounds of carbon-14, of which some eighty individual species can be supplied, there is now added a complete range of amino-acids which have been prepared by biological synthesis. Another new product of interest is the fission product, cæsium-137, which is likely to become important in industrial radiography, and particularly valuable for the radiotherapist is the revised list of radium appliances and the new beta-ray appliances, replacing radium plaques, for superficial therapy of the skin and of the cornea.

Clinical Research Board

The Medical Research Council announces that, in accordance with the recommendations in the White Paper on "Clinical Research in Relation to the National Health Service", a Clinical Research Board has been appointed after consultation, and in agreement, with the Ministry of Health and the Department of Health for Scotland. The Board has been appointed for a period of three years, with the following membership : Sir Geoffrey Jefferson, emeritus professor of neurosurgery, University of Manchester (*chairman*) ; Prof. Dugald Baird, Midwifery Department, University of Aberdeen ; Sir Henry Cohen, Department of Medicine, University of Liverpool ; Prof. E. C. Dodds, Courtauld Institute of Biochemistry, Middlesex Hospital, London ; Sir James Learmonth, Department of Surgery, University of Edinburgh ; Prof. A. J. Lewis, Institute of Psychiatry, Maudsley Hospital, London ; Prof. G. W. Pickering, Medical Unit, St. Mary's Hospital, London ; Prof. R. Platt, Department of Medicine, University of Manchester ; Sir James Paterson Ross, Surgical Unit, St. Bartholomew's Hospital, London ; Sir James Spence, Department of Child Health, King's College, Newcastle upon Tyne ; Prof. B. W. Windeyer, Meyerstein Institute of Radiotherapy, Middlesex Hospital, London. The respective chief medical officers of the Ministry of Health, the Department of Health for Scotland, and the Ministry of Health and Local Government in Northern Ireland will be assessors to the Board, and the secretary of the Medical Research Council will attend all meetings. Dr. F. J. C. Herrald, a senior medical officer on the Council's headquarters staff, will act as secretary of the Board.

Inventions and Designs (Crown Use) Bill

The Inventions and Designs (Crown Use) Bill, the second reading of which in the House of Lords was moved by Lord Mancroft on December 1, purports

to embody in permanent legislation certain emergency powers in regard to the use of inventions and designs which are not patented or registered, and to compel the disclosure of information about them which the Government now possesses under the Defence Regulations. The first clause lists the specified purposes for which the use of inventions or designs may be authorized, including the supply of goods for defence purposes outside the United Kingdom, and the production of drugs, medicines or appliances for the Ministry of Health. The second clause enables a government department to authorize the use, for the services of the Crown, of any unpatented invention or unregistered design or any information relating to it, and to reproduce any model or document, notwithstanding copyright, for that purpose, and to override any agreement regulating its use, subject to compensation from the government department giving the authority.

Although Lord Mancroft claimed that the Bill only retained essential powers and terminated others which were not required, strong objection to the Bill was raised in the debate, and especially to the third clause, which empowers the Ministry of Supply and the Admiralty to call for the disclosure of information relating to any invention or design, whether or not patented or registered, if it appears to be necessary for defence purposes. Lord Mancroft said that the Government recognizes that this is an extreme power to be used very sparingly, but the power was challenged in the debate as a substantial invasion of the liberties of the subject, and as likely both to violate the sanctity of commercial contracts and to have effects on arrangements for the exchange of technical information with overseas firms which would be very detrimental to the interests of Great Britain. Lord Woolton, in replying for the Government, admitted that consultations with industry are still incomplete and, acceding to the pleas of Lord Wilmot, Lord Balfour of Inchrye, Viscount Simon, Lord Silkin and others, moved the adjournment of the debate.

Florida State University

THE State University of Florida has recently published under the ægis of its Research Council the ninth in its series of research studies. These studies were begun in 1950, and, since that time, separate volumes have been published dealing with the University's contribution to the natural sciences, the social sciences, modern languages and literature, history and political science, English and American literature, literature and philosophy, papers from the Oceanographic Institute, and, the most recent, developments in education. The latter includes a study of the Abbé Grégoire and his contribution to education at the time of the French Revolution, the growth of education in Florida during 1821–45 before it became a State, the relation of schools to local and national administration, the problems of junior high-school children, and the use of the cattle industry in Florida as an educational medium for children.

Royal Society : Election of Officers

THE following have been elected officers and Council of the Royal Society for the ensuing year : *President*, Dr. E. D. Adrian ; *Treasurer and Vice-President*, Sir Thomas Merton ; *Secretaries and Vice-Presidents*, Sir Edward Salisbury and Sir David Brunt ; *Foreign Secretary*, Sir Cyril Hinshelwood ; *Other Members of Council*, Dr. F. P. Bowden, Prof. F. Dickens, Prof. H. J. Emeléus, Mr. A. E. Ingham, Dr. G. M. Lees, Prof. E. G. T. Liddell, Prof. R. A. McCance, Prof. P. B. Medawar, Sir Edward Mellanby, Prof. P. B. Moon, Prof. W. H. Pearsall, Prof. R. O. Redman, Prof. Alexander Robertson, Dr. C. Sykes, Prof. G. Temple and Prof. C. M. Yonge.

Announcements

MR. H. BONDI, Fellow of Trinity College, Cambridge, has been appointed to the University of London chair of mathematics tenable at King's College, in succession to Prof. G. Temple, now Sedleian professor of natural philosophy in the University of Oxford (see *Nature*, **171**, 911 ; 1953).

THE Minister of Supply has appointed Dr. R. Cockburn, scientific adviser to the Air Ministry, to be the principal director of scientific research (guided weapons and electronics), and Mr. J. E. Serby, deputy director of the Royal Aircraft Establishment, Farnborough, to be director-general of guided weapons.

THE Chemical Engineering Group and the Food Group of the Society of Chemical Industry are arranging a conference on "Chemical Engineering in the Food Industry", to be held at the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1, during March 18–19, 1954. Further information can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

THE third congress of the International Association of Gerontology will be held in London during July 19–23, 1954. The meetings and discussions will be divided between three main sections : biology and pathology ; geriatric medicine and psychiatry ; and sociology and psychology. Following the congress a number of tours will be arranged to study the care of the elderly in various parts of Britain. Further details can be obtained from the British organizing secretary, Mrs. A. Humphrage, B.M.A. House South, Tavistock Square, London, W.C.1.

THE Swedish Academy of Sciences has issued two supplementary parts to the "Bibliography of J. J. Berzelius", edited by Arne Holmberg, the first dealing with printed works by or about Berzelius, and the second with manuscripts ("Bibliografi över J. J. Berzelius", second supplement, parts 1 and 2. Stockholm : Svenska Vetenskapsakademien, 1953). These include some items which have come to light since the earlier publications and also references to recent works in which statements about Berzelius appear. These supplements are indispensable to those possessing the former publications.

THE Pacific Science Council Secretariat has compiled for the Pacific Science Association a booklet which lists the "Organizations engaged in Scientific Research on an International Scale in the Pacific" (pp. 32 ; from the Association, Honolulu ; 1953). Besides the address, scope of membership and publications of the organizations listed, the booklet gives their objectives and, for some of them, lists the projects on which they are engaged. There are also charts showing the organization and interrelations of the various government and non-government agencies concerned, including the Specialized Agencies of the United Nations, but the projects of these Agencies are not elaborated. Besides the islands of the inner Pacific, the Pacific rim territory is covered, but national and local agencies are not listed.

HEALTH, WELFARE AND EFFICIENCY OF THE WORKER

THE first conference of the British Occupational Hygiene Society was held at the London School of Hygiene and Tropical Medicine on November 2. The conference was opened by the Minister of Labour and National Service, Sir Walter Monckton, who said that provision for occupational health in the widest sense is increasingly concerning the Government. The human element in industry is vital for productivity and, while the primary aim of industrial research is understandably concerned with discovering new and improved methods of production, it must not overlook hygiene and safety factors. The Society, continued Sir Walter, has valuable work to do in bringing together the physician, the medical scientist and the psychologist, who study man, and the physical scientist, chemist and engineer, who study his environment.

In his presidential address, Dr. T. Bedford outlined the development of occupational hygiene in Great Britain, which has grown from a wish to protect young persons and women from the evils of gross overwork some one hundred and fifty years ago. Safety and concern with industrial poisoning date back about ninety years, and the progress made is due to the initiative and devotion of the Factory Inspectorate. It was not until the First World War that concern with productivity, vital for success, resulted in the formation of the Health of Munition Workers Committee, on behalf of which many investigations were undertaken. Since then, various government establishments have worked in the field, and some university departments have also been interested. Further impetus resulted from the Second World War, both in connexion with war industries and with the fighting services.

Dr. Bedford said that occupational hygiene deals with the prevention of disease due to industrial materials and also with the effects of the working environment. The application of physiological and anatomical principles to the design of machines, the arrangement of industrial tasks and psychological factors, such as fatigue and maladjustment of the worker to his vocation or working group, are likewise included. It is to be hoped that the Society will make contributions to all these fields of knowledge.

There are grave deficiencies in the postgraduate medical training available in Britain for medical practitioners who wish to work in industry, and the instruction in methods of measuring and controlling the worker's environment is inadequate. No university in Britain offers a full course for engineers and other non-medical graduates on the lines of those which have been so successful in the United States. This seemed to Dr. Bedford to be a serious lack.

Mr. S. A. Roach, of the Medical Research Council's Pneumoconiosis Research Unit, gave a paper on "Measuring the Worker's Environment", which dealt with pneumoconiosis in the coal industry that is caused by the inhalation of coal dust over a long period. The quantity of dust inhaled is expressed in particle – years per c.c. (sizes between 0·5 and 5 microns), and Mr. Roach claimed that, when this figure was less than 4,000, no X-ray abnormalities were detectable in the sixty colliers who were examined. Fifty per cent abnormalities occurred at more than 24,000 particle – years per c.c.

Dr. D. G. Harvey, of the Medical Research Council's Department for Research in Industrial Medicine, then gave his paper on "Problems of Chemical Toxicity". Pointing out that environmental studies in a chemical industry are often not made until after an accident has occurred, Dr. Harvey made a plea for the investigation of toxic risks before a new substance is used in production. In the determination of atmospheric concentrations, it is not enough to take a few 'grab' samples; mass concentration values over a good length of time, say, one day or a working shift, are essential. Routine determinations of blood and urine levels of a toxic substance give indications of the minimum amount present in the body and are useful for monitoring workers. The elimination-rate can also be found from these observations by removing a man from exposure.

Animal experiments are valuable, continued Dr. Harvey, because, by administering repeated small doses, accumulation in the body can be demonstrated; substances which act like this are particularly dangerous to human beings exposed to chronic intoxication. Quantitative biochemical species differentiation has to be watched for, however, for man is notably inefficient in detoxicating poisons. Thus, initial blood-levels of 60–80 μgm. of 3:5-dinitro-*o*-cresol per gm. are reduced to insignificant amounts in two days in the rabbit, eight days in the rat but forty days in man.

The final speaker was Mr. J. S. Braham, engineering controller of Imperial Chemical Industries, Ltd., who pointed out that, with the industrial capital investment in Great Britain now exceeding £1,000 million a year, the industrial designer is faced with many and complex problems. The potential savings in capital and production cost to be derived from good design are considerable, and the creation of a new plant or factory is a matter for many people who represent the various technical and commercial interests involved. Outlining the principal stages in the growth of a project, Mr. Braham emphasized that the requirements of hygiene ought to be considered in each to some degree and, at certain crucial stages, very closely. Those who are responsible for hygiene cannot be in touch with research, development and design too early. This early contact is very important because hygiene is not a primary consideration of scientific workers engaged in creating a new manufacturing process.

The ensuring of the necessary close co-operation between the industrial hygienist and the designer is a problem of organization and of procedures calculated to bring all the relevant factors under the notice of the proper people at the proper time. This Mr. Braham proposed to facilitate by preparing a special list of all issues of hygiene for routine use as an *aide-memoire*. He also suggested the keeping of a record or history sheet for a project on which would be detailed the consultation of all interests and the implementation of the decisions taken.

Mr. Braham thought that working conditions in British factories are steadily being improved, though some remaining black spots have to be removed. The provision of healthy, safe and agreeable conditions for those who work in them is a moral obligation; it is also an economic necessity for

maximum productivity upon which the prosperity of all depend.

The conference will be reported in full in the January issue of the *British Journal of Industrial Medicine*. The Society is arranging another conference at the London School of Hygiene and Tropical Medicine, on April 6, 1954, when the subject will be on the maximum allowable concentrations of toxic and dangerous air contaminants.

C. N. DAVIES

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

ANNUAL CONGRESS IN LONDON

THE seventh annual congress of the International Scientific Film Association was held during September 18–26 in London on the South Bank, the meetings of the general assembly and specialized groups being in the Royal Festival Hall and the afternoon and evening scientific film shows being in the National Film Theatre. More than one hundred delegates and observers from twenty-two countries and from international bodies (such as Unesco) attended, together with a large number of visitors. At the various sessions more than two hundred and twenty films were shown from twenty-four countries, including some seventy medical films. During the congress Canada and Morocco were made members of the Association.

The congress was opened at the gala première film show on the evening of September 18 by Sir Walter Monckton, Minister of Labour and National Service, who paid tribute to the Scientific Film Association of Great Britain for its work in organizing the congress and for its services to industry generally. The films shown at this performance included contributions from India ("National Physical Laboratory"), Great Britain ("The Desert Locust"; World Wide Pictures, Ltd.), Hungary ("Blossom Time till Autumn Frost"; a remarkable Nature film by Homoki-Nagy), Australia ("Pre-stressed Concrete Tower"), Canada ("Embryonic Development—the Chick"; J. V. Durden), Belgium ("Combat avec l'Ombre"), U.S.S.R. ("Life in the Arctic"; Moscow Popular Science Film Studio, directed by A. Zguridi) and France ("Flammes du Soleil"; Paris Observatory, produced by Jean Painlevé and directed by Joseph Leclerc).

The next day the general assembly met, appointed working committees and transacted the internal business of the Association, adopting the honorary secretary's report and the balance sheet. The congress then divided into its various specialized groups which held meetings during the following six days.

The Research Group held four meetings, two of which were jointly with the Medical and Industrial Groups, respectively. Its first meeting was on the morning of September 20, when three films of research interest were shown and discussed. The first, "Growth of Crystals" (France; Jean Dragescu), used time-lapse and polarized-light techniques to study the crystallization of various stable and unstable substances. The second, "Waters of Coweeta" (United States), was an impressive record of forestry research based on the long-term analysis and measurement of the run-off from watersheds under different conditions. The third, "Biology of the Hamster" (Western Germany; Dr. Gotthard Wolf), was part of a German plan to make an encyclopædia of film and was a complete record of one animal's behaviour during a typical chain of circumstances.

The second research session, jointly with the Industrial Group, was on September 22, when the main subject was "High Speed Films in Industrial Research". There were five contributions—two French and three British. M. Galey, of the Institut de Recherches de la Sidérurgie, showed a film used for investigating the interior of a Martin furnace; it was interesting to compare this with the British contribution by Mr. C. Burns (British Iron and Steel Research Association), who showed a three-dimensional film made to investigate the movements of air and coke particles inside a blast furnace. The technique used enabled actual measurements of high accuracy to be made of the size and shape of the cavity caused by the air blast, and provided a good example of the way films can be used to investigate subjects which cannot be explored by other methods. Mr. John Rogers (Building Research Station) read a paper, illustrated by film, on the uses of the film in building research, which included an interesting description of the use of films in investigating problems of fluid flow. There were a French and a British contribution illustrating railway research: M. Censier, chief of the cinema service of the French national railways, introduced a film showing the use of the high-speed camera on the French railways to investigate speed and wear tests; and Mr. J. C. Lucas (Railway Executive Research Department) showed a film made to investigate a condition of rail wear on electric tracks known as 'periodic side-cutting'.

The third session, on September 23, with Dr. G. Wolf presiding, was a joint meeting with the Medical Group to discuss image converter techniques. Papers were read by Dr. J. S. Courtney-Pratt (University of Cambridge) on the use of image converter tubes in high-speed photography, Mr. A. E. Sarson (Marconi, Ltd.) on the application of television to cinematography and Dr. W. J. Oosterkamp (Philips, Netherlands) on a new X-ray intensifier.

The final research session was on September 26, at the Shell Film Unit, under the chairmanship of Dr. J. Frédéric (Belgium). Ten films were shown and—very briefly—discussed. They included M. R. G. Busnel (France) introducing a film "Enregistrements par une technique electro-accoustique de movements de faible amplitude: applications à la physiologie et la pharmaco-dynamie", which depicted the measurement of small pulsations (beating of a frog's heart, blood vessels in a mouse's foot, etc.) by an apparatus devised by Busnel and Pasquinelly, and amplified and recorded by an oscillograph. Dr. Frédéric showed his film "Recherche expérimentale de Chondriome", investigating and recording movements of mitochrondria when treated with various reagents. Dr. W. Rogers (East Malling) presented "The Freezing of Plant Tissues", which attracted great interest and applause.

Other events during the congress were a well-planned series of industrial sessions, covering the use of films on vocational guidance, training of personnel, motion study and industrial welfare; a conference on the dissemination of science by television, under the chairmanship of Mrs. Mary Adams; a morning session on education addressed by Dr. J. Harrison (Educational Foundation for Visual Aids) and Dr.

H. D. Turner (Extra-mural Department, University of Sheffield); and a session on stereoscopy with Prof. W. D. Wright (Imperial College of Science and Technology, London) in the chair.

During the congress, the general assembly resolved to approach the International Federation of Film Archives to secure international co-operation in the preservation of films relevant to the history of science and technology, and also decided to urge its constituent national organizations to approach their respective governments with proposals for facilitating the interchange of scientific films between different countries.

At the concluding session of the assembly, held on September 26, the officers of the Association for 1953–54 were elected as follows: *President*, Jean Painlevé (France); *Vice-Presidents*, Jan Korngold (Poland) and Prof. Mario Ponzo (Italy); *Honorary Treasurer*, J. W. Varossieau (Netherlands); and *Honorary Secretary*, John Maddison (Great Britain). Sir Arthur Elton, leading the British delegation, paid a warm tribute to the retiring president, John Maddison, for his five years of service in that office.

The eighth annual congress of the Association will be held in Rome during October 1954.

J. Stewart Cook

THE CHILDREN'S FILM FOUNDATION

THE Children's Film Foundation was set up in 1951 with the object of "ensuring the production, distribution and exhibition of special entertainment films for children". The Foundation does not make its own films, but from its own selected programmes it offers each film to those production companies competent to deal with the themes involved. The chosen company then produces the film for a fixed fee and under the supervision of the Foundation. So far, nineteen different companies have produced films for the Foundation.

The Foundation is a non-profit-making organization financed from the British Film Production Fund, Ltd. Its directors are nominated by the British film trade associations, which also elect an independent chairman. Miss Mary Field, the well-known pioneer in children's and Nature films, is the executive officer; and Mr. W. G. R. Thom is secretary and business manager.

Cinemas which organize children's clubs and matinees have agreed to exhibit the Foundation's films in rotation, and five complete programmes are now circulating in Great Britain.

The films so far completed include eight features (one hour each), eight short stories (twenty minutes), eight "Our Magazine" (ten minutes), one novelty (ten minutes), and four pen pictures (ten minutes)—a splendid record for two to three years of work.

The most recent programme of the Foundation's films was presented at the Odeon Cinema, Kensington, London (by permission of the J. Arthur Rank Organization), on December 12 before a packed audience of children which was also graced by the presence of H.R.H. Princess Alice and many local dignitaries. The programme, which lasted two hours altogether, was preceded by an episode of a serial and a cartoon. Then followed one each of the Foundation's latest pen picture, comedy and feature films.

The pen picture is included in these programmes to conform to the Foundation's policy of producing a balanced programme and so including one or more films suitable for children less than nine years of age. The one shown, "A Letter from Wales", took the form of a pictorial letter written by a village boy to a relative abroad. It was obvious that the young audience was intensely interested and were, perhaps subconsciously, learning some human geography. The comedy, "A Good Pull-up", was good fun.

The feature film, "The Secret Cave", was excellent from all points of view. The play was based on Thomas Hardy's "Our Exploits at West Poley". So far as is known, this is the only story Hardy deliberately addressed to juvenile readers. It was commissioned by an American magazine in 1883, but never published. The manuscript remained in the United States and was rediscovered in 1951, when it was published in Britain. For the purpose of the film, the scenes are set on and under the Mendip Hills in Somerset. The underground scenes were made in the famous Wookey Hole Caves. There can be nothing but praise for this excellent children's film from the points of view of open entertainment and subtle teaching. The children followed an exciting story while revelling in the beautiful Mendip scenery, glimpses of Somerset life and the thrill of underground caverns. (The film writer, Mr. J. Mendoza, might have slipped in a verbal picture of the Glastonbury Thorn and the earliest days of Christianity in Britain when one of his juvenile characters is pointing out a very characteristic view of Glastonbury Tor across the Somersetshire plain.)

These three films revealed what excellent work the Children's Film Foundation is doing not only in juvenile entertainment but also in education and training. We came away somewhat confused, however, because each film immediately followed the one shown previously. It occurred to us that if this is the usual practice at children's film matinees then young audiences probably miss some points through such confusion. We know that a crowd of children is impatient when waiting for their entertainment and frequently show their impatience in no uncertain way; but we suggest that a period of three to five minutes might be allowed to elapse between one film and the next. The interval could be filled by some properly organized community singing which the Foundation might consider fostering in the form of very short films of folk songs and traditional and national airs. The words and music could appear on the screen (with an appropriate scenic background—still or moving), and the audience conducted by some form of pointer such as a bouncing white ball passing along the lines of words. From a collection of such community-singing films, those organizing a children's matinee could select the most appropriate song. For example, "The Secret Cave" could have been preceded by "A Farmer's Boy", and "A Letter from Wales" by "Men of Harlech" or "Land of my Fathers".

So far as the films are concerned, we must say that if all films witnessed by children were of the same excellent entertainment and teaching value and of the same artistic merit as those of the Children's Film Foundation, then we should soon begin to hear less about the cinema being one of the contributory causes of juvenile delinquency and more of its considerable value as a visual aid.

Details of the objectives and organization of the Children's Film Foundation can be obtained from Mr. W. G. R. Thom, Children's Film Foundation, Ltd., 73 Newman Street, London, W.1.

REGISTRAR GENERAL'S STATISTICAL REVIEWS OF ENGLAND AND WALES

THE "Medical Text" volume of the "Registrar General's Statistical Review of England and Wales for the two years 1948–49"* is presented in its usual form and provides a commentary on the figures already published in Part 1 of the "Review" for these years. Points of general interest concern the general death-rate, infant mortality, tuberculosis and cancer. The civilian crude death-rate reached a record low level of 11·0 per 1,000 in 1948 (it rose to 11·8 per 1,000 in 1949), partly because of the unusually low rates recorded in the first two quarters of the year. This in turn was due to the remarkable absence of influenza during those quarters. An extensive discussion of the trend of the infant mortality-rates during the past forty-four years shows that the long-term tendency for rates of mortality in the later parts of the first year of life to improve more rapidly than the neo-natal rates has continued. Regional disparities have remained remarkably constant; Greater London showed a greater improvement in 1949 over 1938 than did the North of England and Wales. The greater decline in Greater London was shown in the 'postnatal' rates only, the improvement in the neo-natal rate being very uniform as between the various regions. It is also demonstrated that the social class differential in the infant mortality-rate widened between 1939 and 1949. The postnatal rate for unskilled occupations was 3·8 times as high as the rate for professional occupations in 1939, and 4·4 times as high in 1949. The regional and social class differentials are, of course, closely interconnected. Mortality from tuberculosis began to decline rapidly in 1948. The figures for 1948 and 1949 show a marked shift in the age distribution of mortality from respiratory diseases among males. There was, in fact, an increase in mortality among males aged sixty-five and over in contrast to the great decline at the age range of fifteen to fifty-four. No such shift is shown in female mortality from this cause. The crude death-rate from cancer continued to rise in 1948 and 1949, but the downward trend among women aged thirty-five to seventy-four continued. The contribution of cancer of the lung to the increase in male cancer mortality is discussed. The 'lung' rate among males rose from 866 per million living in the age-range fifty-five to sixty-four during 1940–44 to 1,637 per million in 1949. The extent to which changes in diagnosis may have contributed to the apparent increase in the incidence of cancer of the lung is somewhat inconclusively discussed.

The "Medical Tables" volume, Part 1, for 1951† shows a rise in the crude death-rate to 12·5 per 1,000, partly as a result of the influenza epidemic in the first quarter. Influenza directly caused more deaths than did tuberculosis in this year. The decline in mortality from tuberculosis continued. The number of deaths from this cause in 1951 was 40 per cent lower than that in 1949. The number of deaths from cancer again increased, and accounted for 16 per cent of all deaths in the year.

* The Registrar General's Statistical Review of England and Wales for the two years 1948–49: Text, Medical. Pp. viii+370. (London: H.M.S.O., 1953.) 10s. net.

† The Registrar General's Statistical Review of England and Wales for the year 1951: Tables, Part 1, Medical. Pp. x+474. (London: H.M.S.O., 1953.) 12s. 6d. net

AMERICAN ACADEMIC FREEDOM IN 1953

DESPITE widespread belief to the contrary, Prof. Preston Slosson thinks that the average American professor is one of the freest individuals in the world (*Univ. Rev.*, 26, No. 1; October 1953).

There are four levels on which the American professor is open to attack: the Federal Government, the State Government, the administrative authorities of his own institution and 'pressure groups' with no official status.

The immense publicity attending certain recent investigations by Congressional committees has attracted most attention to the Federal Government, although the actual threat to freedom is least from this source. Congress, like most legislative bodies, has the right to conduct inquiries and investigations into almost any matter which might conceivably become a subject of eventual legislation. This power, in itself, is salutary and useful. Unfortunately, committee investigations have not been surrounded with the legal protections which have been developed for court trials, and questions can be asked at random, no matter how irrelevant or full of false implication. Yet, except for the effect on the professor's reputation, the congressional committee has no power to penalize.

At the State-level, there is quite a variety of educational institutions controlled by State laws and State officials; these include State universities.

The chief power of the State legislature is the power of the purse. The power of rule is almost always in the hands of a board of regents, or a similar body, chosen by appointment or by election to represent the State. Most of them are business or professional men who delegate the details of management to a president, who heads the entire university, and to deans, who head individual colleges or schools within it. The president and the deans, in turn, consult the faculty committees. If the regents are not satisfied with the way things are going, they can change presidents. Full professors, and usually associate professors, have "tenure", that is, contracts guaranteeing permanent employment; younger men are employed for periods of a year or more at a time. Even a professor with tenure can be removed for "sufficient cause" after "due process".

Private colleges and universities are managed in much the same way, except that they are governed by boards of trustees, elected by the alumni, instead of by State-chosen officials. Except for a few academic tragedies of a purely personal sort, there would be few cases of heresy hunting were it not for clamour from angry alumni, parents, taxpayers, and organized pressure groups.

This fourth level is therefore the significant one. Popular clamour has, in times past, been directed at many targets. The only peculiarity of the present situation is that most of the intolerance runs in the single direction of Communists and their alleged sympathizers. Yet in California, where many professors were dismissed for refusing to take a special anti-Communist oath, the State courts ultimately vindicated their stand and held that the requirement was unlawful. The American Association of University Professors has noted no significant increase in the number of professors removed from their posts in recent years, although a few such cases do occur.

A RELATIONSHIP BETWEEN DOMINANCE, PHENOTYPIC STABILITY AND VARIABILITY, AND A THEORY OF ALTERNATIVE GENETIC PATHWAYS

By Dr. D. LEWIS

John Innes Horticultural Institution, Bayfordbury, Hertford, Herts

THE response of an organism to its environment is a problem which has been thought of mainly in terms of the fitness of different genotypes to different conditions. The emphasis has been on the fitness of a heterogeneous population to environmental changes and not so much on the individual's reaction to change. Recently it has been shown in several organisms that the amount of reaction to change, or *variability* within an individual or within a homogenic line, due to non-genetic causes—and therefore due to environment—is gene controlled. This has been shown by comparing variances or suitable functions of the variances of individuals or lines of F_1 generations with their parents grown in one controlled environment. In some species the F_1 was less variable than the parents, and in others, of equal or greater variability. These results are summarized in Table 1.

Table 1. Species examined for F_1 Variability Relative to the Parental Lines

	F_1	Ref.
Outbreeders		
Primula sinensis	Less variable	1
Drosophila melanogaster	,, ,,	2, 3
,, *pseudoobscura*	,, ,,	4
,, *persimilis*	,, ,,	,,
,, *prosaltans*	,, ,,	,,
Inbreeders		
Hordeum vulgare	More ,,	5
Galeopsis species	,, ,,	6

Primula sinensis and the *Drosophila* species are outbreeders while *Hordeum* and *Galeopsis* are inbreeders, and this leads Dobzhansky and Wallace[4] to suggest that the difference in the F_1 variability was due to the different genetic balance attained in outbreeders and inbreeders.

In *Zea mays*[7], an outbreeder, several different characters were examined and it was found that the hybrids could be more, or less, variable than the inbred lines according to the character measured.

A slightly different approach to the problem was started in 1948 by raising plants of *Lycopersicon esculentum* in two different environments and determining the effect of the environment on the mean of the character, the average dominance, and variability. The results from these experiments appear to throw some light on the seemingly conflicting results reported in other organisms, and can be explained in terms of gene action with a theory of alternative genetic pathways. This theory in its simplest form assumes that when different alleles are both operating in a heterozygote each allele may operate through a similar but slightly different synthetic pathway. Each pathway will tend to have its own optimum of environmental condition for operation.

In *Lycopersicon* the character measured was the number of flowers, and the two environments were *H.E.* = 13° C. and *L.E.* = 26° C., maintained during the first few weeks of growth. The *H.E.* has the effect of increasing the number of flowers by a factor of about 1·7 in the pure lines[8]. Two parental pure lines differing in flower number and derivative generations have been compared in the two environments. As a measure of the phenotypic change due to the difference between the two environments, a *stability factor*, $\frac{\text{(mean in } H.E.)}{\text{(mean in } L.E.)}$, was used. As a measure of variability due to "intangible environmental effects produced by developmental accidents or uncontrolled non-genetic variation"[9], the variance or a suitable function of the variance calculated from lines grown in one environment has been used. If a comparison between an F_1 generation and its parents is being made, the term *relative variability* has been adopted which is denoted by

$$\frac{2F_1 f(v)}{f(v)(P_1 + P_2)}$$

$f(v)$ = suitable function of variance, v

Some of the results of the experiments can be summarized as follows:

1. The dominance, or more strictly speaking average dominance since we are dealing with a polygenic character, is changed by the environment: low flower number being dominant in the *H.E.*, and intermediate in the *L.E.*

2. The F_1 is more phenotypically stable than the two parents in relation to the two environments. This is caused by the change to dominance by an environment which is having the opposite effect on the character to that of the gene. For example, low number is dominant only in the high expression (*H.E.*) environment. A theoretical model shows that the F_1 need not necessarily be more stable than the parents; for example, when the high number of flowers is dominant only in the *H.E.*, the F_1 would be less stable than the parents.

3. The relative variability of the F_1, as measured in one environment, is related to the degree of dominance operating with the particular environment and genetic situation. Complete lack of dominance results in low F_1 relative variability: dominance is accompanied by a high F_1 relative variability, which can, in some cases, be higher than the parents.

A search for data in the literature suitable for an analysis into relative variability and dominance has revealed figures for plant-height and leaf-length in *Nicotiana rustica*[10].

Relative variabilities and dominance values based on Wigan's[11] formula have been plotted for the *Nicotiana* and *Lycopersicon* data in Fig. 1.

The dominance is represented along the horizontal axis: a value of 0·5 represents complete lack of dominance, a value of 0·0 represents complete dominance of the larger, and 1·0 complete dominance of the smaller, character expression. The *Nicotiana* data supply the left arms of the V graph, the *Lycopersicon* data represent the right arm. It should be pointed out that the points representing the *Lycopersicon* data are from populations of one hybrid and pair of parents but from different treatments or parts of the plant, while the *Nicotiana* data are from different hybrids and parents all grown under the same environment.

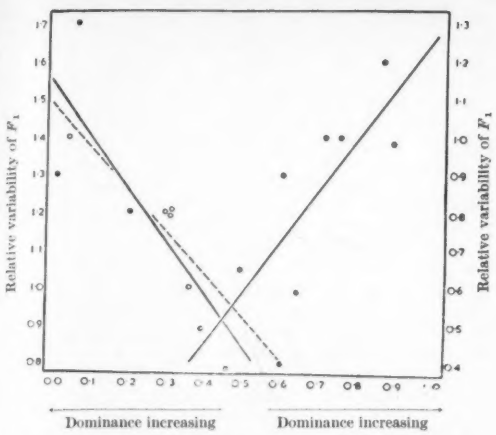

Fig. 1. Relationship between dominance and F_1 relative variability. Note that absence of dominance, with a value of 0·5, gives the lowest relative variability; as the degree of dominance increases so does the relative variability. The right-hand arm of the graph and the ⊙ points represent flower number data from *Lycopersicon*; the two left-hand arms represent data from *Nicotiana*, ●, ——— = plant-height, O – – – = leaf-length. Lines are based on regression coefficients

It is clear from the graph that the lowest F_1 variability is obtained with the minimum of dominance; and the good agreement in two species suggests that this relationship may be generally applicable.

A re-examination from this aspect of the published examples which are not suitable for graphical representation supports this view. Thus the *Galeopsis* and *Hordeum* hybrids exhibit dominance and high F_1 variability. In an interspecific hybrid in *Petunia*[12] the F_1 is intermediate with no dominance and is less variable than the parents.

The relationship between heterosis and F_1 variability is another aspect of the problem, but at present there are too few data to allow of a generalization. In *Lycopersicon*, certain hybrids obtained from F_2 selections for flower number showed negative heterosis and high F_1 variability. Certain hybrids in *Galeopsis*[6] showed positive heterosis and high F_1 variability. If in these cases heterosis was due to favourable dominant genes, then the high F_1 variability is in agreement with the dominance-variability relationship. Other types of heterosis involving balanced heterozygosity probably occur, and these may be expected to show a different relationship.

The relationships found between dominance and F_1 variability, and between change of dominance and phenotypic stability, are given a certain unity by the theory of alternative genetic pathways. It is assumed that when an allele is completely recessive, it is not in operation. Thus the maximum number of alternative pathways will be in a heterozygote which does not show dominance. The high number of different pathways with their different optima will tend to damp the effect of environment and result in a lower non-genetic variability. The change of dominance due to big environmental differences can be explained on the opening or closing of certain pathways by the environment. The particular pathway affected by an environment will determine the phenotypic stability to the environmental difference being tested.

Another model for such a theory has been provided in the antigenic system in *Paramecium*[13], in which genes come into operation under different conditions. The similarity between the alternative genetic pathway concept and that of alternative biochemical syntheses of Hinshelwood[14] to account for adaptation in micro-organisms is obvious. The adaptation in micro-organisms, due to the switch-over to an alternative biochemical synthesis, should occur only when there is the alternative genetic pathway to carry it out. Alternative genetic pathways probably also influence ecological adaptation in higher organisms.

[Dec. 3.

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A HEATING INSTRUMENT FOR THE ACCURATE DETERMINATION OF MESOMORPHIC AND POLYMORPHIC TRANSITION TEMPERATURES

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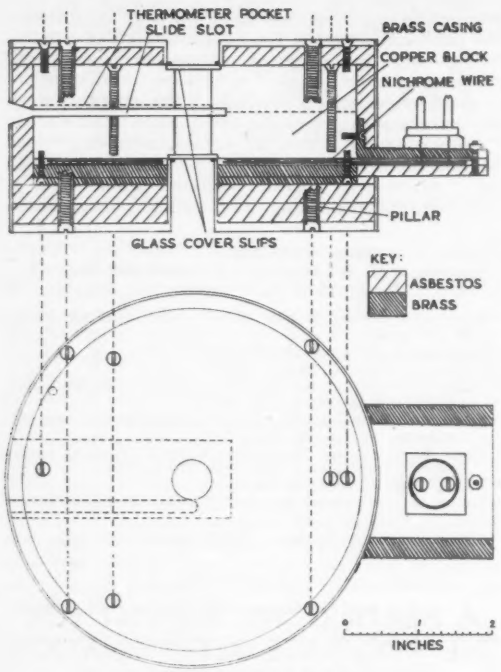
TEMPERATURES for the transitions of solid to smectic or nematic, smectic to nematic, and smectic or nematic to isotropic may be obtained in a melting-point capillary in a well-stirred paraffin bath, because of differences in the appearance and behaviour of these states. The solid and the isotropic liquid are readily distinguished from the smectic state, which appears as viscous, opaque droplets adhering to the capillary walls, and from the nematic state, which is also opaque, but mobile and fluid. The smectic–nematic change may therefore be taken as the temperature at which the viscous smectic state coalesces and flows to a cloudy melt. However, erroneous results were obtained in the case of certain 4 - *n* - alkyloxy - 4′ - carboxy - diphenyls, the smectic and nematic states of which interchange at high temperatures (240–260°). At these temperatures, the viscosity of the smectic state decreases to such an extent that flowing occurs before the sample assumes nematic properties. Moreover, the capillary method is subject to error, since abrasions in the glass and the amount of material may affect the ease of flow. Furthermore, polymorphic transitions pass unnoticed in a melting-point capillary.

The need arose for a means of heating samples at easily and carefully controlled temperatures, while observing the material under a microscope. In this way, solid–solid changes will be visible, and the mesomorphic transitions will be seen as actual changes in the appearances[1] of the phases. Such an instrument, which was constructed in our work-



Microscope heating block

shops, is now described, and has been used for the accurate determination of the constants of a large number of mesomorphic substances. A plan and elevation of the instrument are shown.

To minimize temperature gradients in the block, high-conductivity copper was used. The block is approximately 4¼ in. in diameter and 1¼ in. thick, and consists of two parts which are bolted together. The ½-in. diameter hole is covered above and below by glass cover slips, which are held in position by spring clips. These minimize air currents, which give localized cooling on the part of the slide examined under the microscope. When operating at high temperatures (above 200°), considerable sublimation occurs and makes the upper cover slip opaque. Since this cannot easily be removed for cleaning, the upper cover slip is replaced when high temperatures are used by an ordinary microscope slide, which lies over the hole, on top of the outer casing. As the slide becomes opaque, it is gradually pushed over to a clean part. This makes continuous observation easy even when rapid sublimation occurs. The slide slot is cut to allow easy insertion and removal of a slide, and the thermometer pocket is drilled so that the surface of the bulb is exposed to the air in the hole between the cover slips. The recorded temperature is therefore that of the sample mounted on the end of the slide, and not merely that of the copper beside the hole. Samples were mounted by melting between a glass slide and a cover slip, to obtain a thin film of the specimen.

The heater consists of 22 ft. of 36-gauge nichrome wire (diameter 0·0076 in.), with a resistance of approximately 250 ohms. The wire is wound on a circle of mica sheet (3¾ in. diameter), with a ¾-in. hole in the centre. Slightly larger mica sheets, of the same shape, are placed on either side, and the heater unit is secured against the underside of the block by two brass plates of the same pattern as the copper block to which they are bolted. The heater wires are led off from beneath the block to the plug, which is attached to an L-shaped brass plate bolted to the side of the block.

A brass outer case for the block was constructed. Two ⅛-in. thick brass plates of approximately 5 in. diameter, with a ¾-in. hole in the centre, are supported 2⅜ in. apart by four pillars of brass tubing to which the plates are bolted. The thin brass outer casing is bent around the circular plates and bolted to the pillars. The heating block is housed in this case, from which the plug mounting protrudes. Two brass tubes are let into the top and bottom of the casing and meet the copper block beside the spring clips which secure the glass covers. These tubes are soldered and brazed in position, and complete the outer jacket. Asbestos board, two ¼-in. layers below and one ¼-in. layer above, and asbestos cement around the sides insulate the copper block. The upper plate of the case is securely bolted through the upper insulation to the top of the copper block.

The instrument is mounted on the rotating stage of a Baker polarizing microscope. The supporting bracket of this instrument has been cut and a 4¼-in. brass column inserted to raise the barrel and focusing arrangement well above the stage. Using a 1½-in. objective there is a clearance of 0·6 in. between it and the insulated top of the casing.

A variable resistance of 850 ohms in the external circuit controls the rate of heating, as shown by the figures in the accompanying table.

Resistance in external circuit (Ω)	Temperature at (min.)				Rate of temp. rise (degrees per min.)	
	0	60	120	180	First 30 min.	Last 30 min.
0	9°	320°	—	—	7·2°	3·2°
100	10°	194°	248°	268°	4·0°	0·13°
200	10°	135°	174°	192°	2·7°	0·1°
300	12°	82°	123°	136°	1·6°	0·1°
400	17°	74°	98°	106°	1·3°	0·1°
500	20°	57°	76°	85°	0·8°	0·07°

The accuracy of the instrument was determined by taking melting points of purified organic compounds covering a range of temperature from 40° to 360°. The melting points were also determined in the usual way. The corrected values, by the two methods, agreed within ± 0·25 deg., provided that the optimum rate of heating in the region of the melting point was 2 deg./min.

The design of the instrument, with a slide slot in the side, has the advantage that there is a slight temperature gradient across the specimen. Melting begins at the side, away from the slot opening, and passes quickly, but as a well-defined wave front, across the field of vision. This is valuable in the determination of certain transitions which would be difficult to detect if they occurred uniformly over the sample.

Mesomorphic and polymorphic transitions were determined in the following way. The slide was inserted in the heating block and the temperature raised fairly rapidly (5 deg./min.) to obtain the approximate solid–solid transition temperatures. The block was allowed to cool until the stable solid reappeared and the measurements repeated, using

a rate of heating of 2 deg./min., from 10 deg. below the transition point and until each transition had occurred. The mesomorphic transitions were, of course, indicated by the ordinary melting-point determinations. The temperature was therefore raised quickly to within 10 deg. of each value, and then controlled, using a suitable resistance in the external circuit, to a rate of increase of 2 deg./min. The transitions were seen as a wave front, and the phase type identified as smectic, nematic, or cholesteric by its appearance[1], which was always well defined in polarized light. The transition to the isotropic liquid occurred when the field of vision became extinct in polarized light. [Aug. 17.

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TOXIC FLUORINE COMPOUNDS

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MONOFLUOROACETIC acid and its derivatives have received widespread attention during and since the Second World War, because of their interesting and varied pharmacological effects on different species of animals. From 1942 onwards, methyl fluoroacetate has been studied extensively[1], and its toxicity (*L.D.* 50, 15 mgm./kgm. for mice) used as a standard reference figure for all new compounds prepared. Many of the salient pharmacological features have been reviewed[2,3]; it has been shown that the point of attack of these agents is either the central nervous system or the heart, and the *L.D.* 50 can vary from as low as 0·06 mgm./kgm. in the dog to well over 500 mgm./kgm. in the case of the South African clawed toad (*Xenopus laevis*). Death may result from: (*a*) respiratory arrest following severe convulsions; (*b*) gradual cardiac failure or ventricular fibrillation; or (*c*) progressive depression of the central nervous system with either respiratory or cardiac failure as the terminal event. A latent period varying from thirty minutes to several hours always occurs before the symptoms develop.

In 1947, a remarkable alternation in toxicity of members of an ascending homologous series of ω-fluorocarboxylic esters was reported[4,5]. Considering the general formula $F(CH_2)_nCOOR$, it was established that if n is odd (n = 1, 3, 5, 7, 9, 11), the compound is toxic and produces symptoms in animals similar to those produced by fluoroacetic acid, whereas if n is even (n = 2, 4, 10), the compound is devoid of toxic properties. In other words, those esters containing an even number of carbon atoms are toxic, whereas the odd-numbered members are innocuous.

This alternation in toxicity has been correlated with the β-oxidation theory of the breakdown of long-chain carboxylic acids in the animal body[6]. It can be seen that β-oxidation of the even-numbered members would yield the toxic fluoroacetic acid in all cases, whereas the odd-numbered members would be oxidized only so far as the non-toxic 3-fluoropropionic acid. Recently, this conclusion has been confirmed in part by the finding of citric acid in the brain of animals treated with sodium 4-fluorobutyrate or sodium 6-fluorohexanoate[7], indicating a partial conversion of these substances to fluoroacetate, the latter causing the accumulation of citric acid as described by Peters[3].

It was on account of the above observations that the present research project was initiated. Its purpose was two-fold: first, to study the chemistry of ω-fluoro-organic compounds, the reactions and properties of which are relatively unknown in contrast with those of the other often-studied ω-halogeno-compounds; and secondly, to obtain new fluorine compounds which we predicted would be of pharmacological interest.

Each new compound prepared was analysed in order to confirm its identity and purity, and all necessary physical constants were determined. A sample of each pure compound was then submitted for toxicity determinations on mice by subcutaneous injection using propylene glycol as solvent. In most cases, death was accompanied by typical fluoroacetate-like symptoms. Even though mice often give unreliable and inconsistent results compared to dogs and monkeys, they were used in this investigation on account of their ready availability. Moreover, since previous workers had used mice for toxicity screening, our continuation allowed ready correlation with related compounds.

This report surveys very briefly some of the toxicological results of various new series of aliphatic compounds containing an ω-fluorine atom. An attempt has been made to correlate chemical structure with toxicity, although this feature of the work is still incomplete. Full details of preparation, physical constants and analytical data, together with a more complete bibliography, will be presented in the appropriate journals in due course.

ω-Fluorocarboxylic acids and derivatives, $F(CH_2)_nCOOR$. For completeness, we prepared[8] the two missing members of the ω-fluorocarboxylate series mentioned above, ethyl 7-fluoroheptanoate, $F(CH_2)_6COOEt$, and ethyl 9-fluorononanoate, $F(CH_2)_8COOEt$. Both were non-toxic as expected. This added further confirmation to the β-oxidation theory and completed the first eleven members of the series. In no instance has an exception to the toxicity rule been found. One higher ester, ethyl 16-fluorohexadecanoate, $F(CH_2)_{15}COOEt$, was prepared[8] and as predicted had an *L.D.* 50 of about 7 mgm./kgm. The remarkable fact about this derivative was that toxic symptoms apparently developed much more rapidly than those caused by the standard, methyl fluoroacetate. These new derivatives were prepared from the corresponding ω-bromo-esters by halogen exchange using metallic fluorides. Recently, we have also prepared 18-fluorostearic acid, $F(CH_2)_{17}COOH$, by oxidation of 18-fluorooctadecanol, and preliminary work indicates that its toxicity is slightly greater than was expected, notwithstanding its very low solubility in aqueous media. Revised figures for the *L.D.* 50 of the ω-fluorocarboxylate series are shown in Table 1.

ω-Fluoroalcohols, $F(CH_2)_nOH$. The preparations of the above ω-fluorocarboxylates were all long and required *ad hoc* methods for each individual member. It seemed desirable to find a corresponding series, all the members of which could be obtained by a general method starting from cheap, readily accessible materials. Since the biological oxidation of alcohols to acids has long been known, the homologous series of ω-fluoroalcohols was next examined. The members prepared so far[8–11] are summarized in Table 1.

Once again a pronounced alternation in toxicity is apparent with ascent of the series, with the same

Table 1

Formula of ω-Fluoroalcohol	*L.D.* 50 for mice (mgm./kgm.)	Formula of corresponding ω-Fluorocarboxylate	*L.D.* 50 for mice (mgm./kgm.)
FCH_2CH_2OH	15	FCH_2COOCH_3	15
$F(CH_2)_2OH$	46·5	$F(CH_2)_2COOH$	> 100
$F(CH_2)_3OH$	0·9	$F(CH_2)_3COONa$	4·0
$F(CH_2)_4OH$	> 100	$F(CH_2)_4COOEt$	> 100
$F(CH_2)_5OH$	1·24	$F(CH_2)_5COONa$	3·0
$F(CH_2)_6OH$	80·0	$F(CH_2)_6COOEt$	> 100
$F(CH_2)_7OH$	0·6	$F(CH_2)_7COOEt$	9·0
$F(CH_2)_8OH$	32·0	$F(CH_2)_8COOEt$	> 100
$F(CH_2)_9OH$	1·0	$F(CH_2)_9COOEt$	10·0
$F(CH_2)_{10}OH$	> 100	$F(CH_2)_{10}COOEt$	> 100
$F(CH_2)_{11}OH$	1·5	$F(CH_2)_{11}COOH$	1·25
		$F(CH_2)_{15}COOEt$	7·0
$F(CH_2)_{16}OH$	4·0	$F(CH_2)_{17}COOH$	5·7

generalizations applying to the odd- and even-numbered homologues. Moreover, it can be seen that most members of the ω-fluoroalcohol series are considerably more toxic than the corresponding members of the ω-fluorocarboxylate series. In particular, 8-fluorooctanol is about fifteen times as toxic as ethyl 8-fluorooctanoate, and more than forty times as toxic as methyl fluoroacetate on a molar basis.

The synthesis of the ω-fluoroalcohols can be carried out by various general routes:

(1) $HO(CH_2)_nOH \xrightarrow{HCl} Cl(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$

(2) $X(CH_2)_nX \xrightarrow{KF} F(CH_2)_nX \xrightarrow{hydr.} F(CH_2)_nOH$

(3) $CH_2{=}CH(CH_2)_{n-2}OH \xrightarrow{HBr,\ air} Br(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$

(4) $(CH_2)_{n-2}\langle\begin{matrix}CH_2\\O\\CH_2\end{matrix}\rangle + HX \rightarrow X(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$

(5) $(CH_2)_{n-2}\langle\begin{matrix}CH_2\\O\\CH_2\end{matrix}\rangle + HF \rightarrow F(CH_2)_nOH$

(6) $F(CH_2)_{n-1}COOR \xrightarrow{LiAlH_4} F(CH_2)_nOH.$

All the above methods have been employed successfully for the preparation of at least one member of the ω-fluoroalcohol series, and most are general for the entire series. So far, route (1) has proved to be the most satisfactory because of the ready availability of the glycols, which in turn can be prepared from the corresponding dibasic acids.

Early in this work, we realized the need for a reducing agent which would reduce the functional groups of monofluorinated aliphatic derivatives without simultaneous loss of fluorine. The use of standard basic reducing agents was prohibited because of the ready removal of hydrogen fluoride with concomitant unsaturation or cyclization, while high-pressure hydrogenation readily formed the corresponding non-fluorinated material[6]. In spite of the basic nature of lithium aluminium hydride and of the reported dehalogenation of monohalogenated derivatives[12], we thought that this reagent might still be effective for our purpose due to the mild conditions employed in the reaction and to the greater stability of the carbon–fluorine bond relative to that of the other carbon–halogen bonds. This theory has now been verified experimentally[11], and lithium aluminium hydride has been used to advantage in route (6) for the reduction of ethyl 11-fluoroundecanoate to 11-fluoroundecanol (96 per cent yield), and of 12-fluorododecanoic acid to 12-fluorododecanol (50 per cent yield). Further reference to other reductions will be made later, in particular to the reduction of fluorinated nitriles and nitro-compounds to fluorinated amines[11,13], and of fluorinated thiocyanates to fluorinated mercaptans[11].

ω-*Fluoroaldehydes*, $F(CH_2)_nCHO$. Fluoroacetaldehyde, FCH_2CHO, the simplest member of the series, has been reported[14] to have a toxicity similar to that of methyl fluoroacetate and fluoroethanol. It was never isolated in a pure state, since the anhydrous material polymerized rapidly, and all toxicity studies were carried out on the hydrate, $FCH_2.CH(OH)_2$.

The ω-fluoroaldehydes were expected to follow the toxicities of the corresponding acids and alcohols, and in confirmation of this we have prepared[11] 10-fluorodecanal, $F(CH_2)_9CHO$, the aldehyde corresponding to 10-fluorodecanol.

The compound was made by the method outlined below:

$$HO(CH_2)_9CH{=}CH_2 \xrightarrow{PBr_3} Br(CH_2)_9CH{=}CH_2 \xrightarrow{KF} F(CH_2)_9CH{=}CH_2 \xrightarrow{H.COOOH} F(CH_2)_9CH(OH)CH_2OH \xrightarrow{KIO_4} F(CH_2)_9CHO.$$

The *L.D.* 50 of 10-fluorodecanal as determined by subcutaneous injection into mice was 1·95 mgm./kgm., that is to say, its toxicity is almost identical with that of 10-fluorodecanol. This adds further evidence of the ready interconversion of alcohols, aldehydes and acids *in vivo*.

It is of interest that the intermediate 11-fluoro-1,2-dihydroxyundecane, $F(CH_2)_9CH(OH).CH_2OH$, has an *L.D.* 50 of 1·75 mgm./kgm., that is, very similar to that of 10-fluorodecanal, $F(CH_2)_9CHO$, and in contrast to the non-toxic 11-fluoroundecanol, $F(CH_2)_9CH_2CH_2OH$. It seems probable, then, that the α-glycol grouping of 11-fluoro-1,2-dihydroxyundecane is being split *in vivo* to yield the toxic 10-fluoroaldehyde and afterwards 10-fluorodecanoic acid. This type of reasoning, although based on such scanty data as crude toxicity figures, affords the first evidence for the metabolic scission of α-glycols and at the same time illustrates an application of fluorine compounds to the study of biochemical mechanisms.

ω-*Fluoronitriles*, $F(CH_2)_nCN$. These derivatives were originally prepared for comparison with the parent acids. Moreover, from a consideration of the reported breakdown of nitriles *in vivo* to hydrogen cyanide and the next lower acid[15], it seemed probable that the nitriles with an odd number of carbon atoms might be more toxic than the even-numbered members. For example:

$F(CH_2)_4CN \rightarrow F(CH_2)_3COOH$ (toxic) + HCN (toxic).

The members already prepared[11] support this hypothesis, as is shown in Table 2.

Table 2

Compound	Formula	*L.D.* 50 for mice (mgm./kgm.)
Fluoroacetonitrile	FCH_2CN	25
4-Fluorobutyronitrile	$F(CH_2)_3CN$	16
5-Fluorovaleronitrile	$F(CH_2)_4CN$	1·0
6-Fluorohexanonitrile	$F(CH_2)_5CN$	50
7-Fluoroheptanonitrile	$F(CH_2)_6CN$	2·7
12-Fluorododecanonitrile	$F(CH_2)_{11}CN$	80

The contribution of the hydrogen cyanide to the overall effect is indicated by the decrease in toxicity with ascent of the even-numbered members of the series.

Again, biochemical conclusions can be drawn from these toxicity figures. It can be seen: (*a*) that the nitriles are not hydrolysed appreciably *in vivo* by the standard chemical route ($R.CN \rightarrow R.COOH$), since the toxic odd members would give rise to non-toxic acids, whereas the reverse is the case; (*b*) that they are not reduced *in vivo* to the corresponding amines ($R.CN \rightarrow R.CH_2NH_2$) since the toxic odd members would give rise to amines containing an odd number of carbon atoms, and these are shown in the next section to be non-toxic; but (*c*) that, on the contrary, the most satisfactory way of explaining the high toxicity of the odd members is to accept the somewhat implausible theory of C—CN rupture, giving the toxic even-numbered fluoro-acids plus hydrogen cyanide. This work thus confirms the original postulate of nitrile metabolism.

The ω-fluoronitriles were prepared easily and in very good yield by treatment of the corresponding ω-fluoroalkyl halides with sodium cyanide.

ω-Fluoroalkylamines, $F(CH_2)_nNH_2$. ω-Fluoro-primary amines were examined in accordance with the routine preparation and screening of ω-fluoro-derivatives. The even-numbered members were expected to be toxic on the grounds that normal amines undergo detoxication to the corresponding acid[17].

$$F(CH_2)_5CH_2NH_2 \rightarrow F(CH_2)_5CH{=}NH \rightarrow F(CH_2)_5CHO \rightarrow F(CH_2)_5COOH \text{ (toxic)}.$$

The four members which we have prepared[11,13] substantiate this general hypothesis as is shown in Table 3.

Table 3

Compound	Formula	*L.D.* 50 for mice (mgm./kgm.)
3-Fluoropropylamine	$F(CH_2)_3NH_2$	46
5-Fluoroamylamine	$F(CH_2)_5NH_2$	50
6-Fluorohexylamine	$F(CH_2)_6NH_2$	0·9
7-Fluoroheptylamine	$F(CH_2)_7NH_2$	50

Further members are being investigated, in particular, 2-fluoroethylamine, which has been prepared previously[18], 4-fluorobutylamine and 8-fluorooctylamine.

The ω-fluoroalkylamines were prepared by reduction of the corresponding ω-fluoronitriles using lithium aluminium hydride, or of the corresponding ω-fluoro-ω′-nitroalkanes using either lithium aluminium hydride or catalytic low-pressure hydrogenation.

ω-Fluoro-ω′-nitroalkanes, $F(CH_2)_nNO_2$. The four members listed in Table 4 were prepared[13,15] by treating the corresponding ω-fluoroalkyl bromide with silver nitrite in boiling ether. Once again, an alternation in toxicity is apparent.

The minimum lethal doses of the lower non-fluorinated mononitroalkanes lie between 250 and 1,000 mgm./kgm. when these compounds are administered orally to rabbits[19]. It has been shown[20,21] that when nitroethane is administered intravenously to rabbits, the main metabolic products are acetaldehyde and nitrite ions, with smaller amounts of acetic acid and nitrate ions. Similar products were obtained *in vitro* using hydrogen peroxide as the oxidizing medium:

$$CH_3CH_2NO_2 + H_2O_2 \rightarrow CH_3.CHO + HNO_2 + H_2O.$$

The presence of acetic acid and nitrate ions was attributed to secondary oxidation of the main products. Assuming that the ω-fluoro-ω′-nitroalkanes follow the same metabolic pathway, the expected products are the corresponding aldehydes and acids, together with nitrite and nitrate ions. Accordingly, it is postulated that the toxicity of the ω-fluoro-ω′-nitroalkanes is due in part to the formation of the corresponding ω-fluoro-carboxylic acids and that the even-carbon members are the more toxic due to the higher toxicity of the even-carbon fluoro-acids.

Table 4

Compound	Formula	*L.D.* 50 for mice (mgm./kgm.)
3-Fluoro-1-nitropropane	$F(CH_2)_3NO_2$	9½
4-Fluoro-1-nitrobutane	$F(CH_2)_4NO_2$	11
5-Fluoro-1-nitropentane	$F(CH_2)_5NO_2$	90
6-Fluoro-1-nitrohexane	$F(CH_2)_6NO_2$	12·5

Summary

Representative members of various chemical species containing an ω-fluorine atom have been prepared and tested on mice by subcutaneous injection; chemical series described in this report include ω-fluorocarboxylates, ω-fluoroalcohols, ω-fluoroaldehydes, ω-fluoronitriles, ω-fluoroamines and ω-fluoro-ω′-nitroalkanes. An attempt has been made to correlate the toxicities with known metabolic mechanisms. A second report will survey our work on the following and other topics: ω-fluoro-halogen derivatives, several types of ω-fluoro-sulphur derivatives, ω-fluoroalkenes and ω-fluoroalkynes, methods of fluorination, new synthetic routes and possible commercial outlets for these materials.

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The following have collaborated in this work: R. M. Hill, W. C. Howell, S. B. D. Hunt, A. J. McNamara, J. C. Schneider, J. F. Walker and R. W. White. [Oct. 3.

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LETTERS TO THE EDITORS

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Reproducibility of Differential Centrifugation Experiments in Tissue Fractionation

During the past few years, differential centrifugation of tissue homogenates has become one of the major techniques of cytology and biochemistry alike. Most of those who have applied this new technique describe the conditions of centrifugation by mentioning only the duration of operation and the centrifugal field prevailing in the middle (or at the bottom) of the tube; the type of centrifuge used is sometimes also mentioned. However, the information thus supplied is not sufficient to enable other workers to reproduce the conditions, especially when another type of instrument is to be used. This fact may be partly responsible for the wide variations which are sometimes encountered between results obtained in different laboratories.

Since different types of instruments cannot be expected ever to furnish identical results, the definition of a suitable unit raises some difficulties in itself. However, if the approximation is made that angle centrifuges can be regarded as similar to radial centrifuges in which the top and bottom of the fluid are separated from the axis by the same distances[1], different instruments become comparable with each other and the formula of sedimentation in a radial direction can be applied. When used for preparative purposes, a centrifugation is then best described by the characteristics of the lightest spherical particles which are completely sedimented under the conditions used.

The relationship between the variables involved is given by the formula:

$$2{\cdot}3 \log_{10} \frac{R_{\max.}}{R_{\min.}} = \frac{2r^2 (d_\rho - d_m)}{9\eta} \int_0^t \omega^2 dt, \qquad (1)$$

in which $R_{\max.}$ and $R_{\min.}$ are the distances (in cm.) separating the bottom and the surface of the fluid respectively from the axis during centrifugation; r is the radius of the particle (in cm.); d_p and d_m are the densities of the particle and of the medium respectively (in gm./cm.^{3}); η is the viscosity of the medium (in poises); ω is the angular velocity (in rad./sec.); and t is the time (in sec.).

From this formula, three values are required: $R_{\max.}$, a characteristic of the instrument and, eventually, of the type of tube used; $R_{\min.}$, a value which is dependent on the type of instrument and tube, and also on the amount of fluid centrifuged; $\int_0^t \omega^2 dt$, the time integral of the squared angular velocity.

With instruments which accelerate and decelerate rapidly, and which are run during a relatively long time, the latter value is described accurately enough by giving the time during which the power is turned on and the angular velocity at plateau speed. When such is not the case, it is necessary to work out the whole integral. It can then be expressed by means of the actual time of operation and of the equivalent mean angular velocity.

Another alternative would be to give simply the sedimentation constant of the lightest spherical particles which are sedimented completely:

$$s = \frac{2r^2 (d_\rho - d_m)}{9\eta} = \frac{2{\cdot}3 \log_{10} \frac{R_{\max.}}{R_{\min.}}}{\int_0^t \omega^2 dt}. \qquad (2)$$

It should be pointed out that the use of the average field, expressed in terms of the gravity constant g, rather than the angular velocity, tends to render results less reproducible.

If the average field is defined as the field prevailing at a distance $R_{\text{av.}} = 0{\cdot}5\,(R_{\max.} + R_{\min.})$ from the axis:

$$g_{\text{av.}} = \frac{1}{981}\,\omega^2 R_{\text{av.}}; \qquad (3)$$

equation (2) then becomes:

$$s = \frac{2{\cdot}3\,R_{\text{av.}} \log_{10} \frac{R_{\max.}}{R_{\min.}}}{981 \int_0^t g_{\text{av.}}\, dt}. \qquad (4)$$

Since individual centrifuges differ more by the absolute values of their radii than by the ratio of these values, they are less comparable, so far as complete sedimentation is concerned, when developing equal average fields than when turning at equal velocities. The converse is obviously true when the rate of sedimentation in the middle of the tube is considered. But in preparative centrifugation, it seems more logical to use complete sedimentation as criterion of comparison.

One can, of course, maintain the convention of expressing the conditions of centrifugation by means of the average field; but it then becomes of special importance to give the values of $R_{\max.}$ and $R_{\min.}$ accurately. In this case, the time integral of the average field can be conveniently expressed in a composite unit, *g*.min., or alternatively, as the equivalent of x minutes at y times g. If, as is usually the case, the angular velocity is expressed in revolutions per minute (r.p.m.) and the time T in minutes, equations (2) and (4) become:

$$s = 3{\cdot}5 \frac{\log_{10} \frac{R_{\max.}}{R_{\min.}}}{\int_0^T (\text{r.p.m.})^2\, dT} = 3{\cdot}9 \times 10^{-5} \frac{R_{\text{av.}} \log_{10} \frac{R_{\max.}}{R_{\min.}}}{\int_0^T g_{\text{av.}}\, dT}. \qquad (5)$$

In equations (2), (4) and (5), s is given in sec.; it can also be expressed in Svedberg units (10^{-13} sec.) and must then, of course, be multiplied by 10^{13}.

There is little doubt that better reproducibility will be obtained if the conversion from one instrument to another is based on one of these equations. Of course, differences must still be expected, since the equations are based on an approximation in the first place, and also they neglect such factors as diffusion and convection currents, which may be more important in one type of instrument than in another. In addition, the manner in which decantation is performed may be of paramount importance and should be mentioned as well.

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Enzymic Content of the Mitochondria Fraction

A LARGE number of enzymes have been located in the mitochondria fraction isolated by means of differential centrifugation; this fact is generally assumed to indicate that they are structurally associated within the living cell. Recent studies, part of which were presented at the second International Congress of Biochemistry[1], have shown that this conclusion is not necessarily warranted. It has been found that the acid phosphatase of rat liver, which comes down predominantly with the large granules in a form which, in the native particles, is practically devoid of activity towards added glycerophosphate at *p*H 5 [2-4], does not belong to the same type of granules as cytochrome oxidase.

The phosphatase-containing granules require larger centrifugal fields in order to sediment completely than do those bearing cytochrome oxidase, and can be further separated from the latter by washing or by a layering technique. The sedimentation properties of the two classes resemble each other too closely to permit a complete separation; but it is possible to isolate head fractions which are very rich in cytochrome oxidase and almost free from acid phosphatase and tail fractions showing a reverse relationship.

Similar observations have been described by Novikoff, Podber, Ryan and Noe[5], but have been interpreted by these authors as showing that the cytoplasmic granules have a heterogeneous enzymic composition. Our contention, on the other hand, is that granules of a given class may be homogeneous, but that the isolated fractions are heterogeneous and contain representatives of several distinct classes. This contention is theoretically acceptable, since contaminations must be considered inevitable in differential centrifugation; it is supported by the efficiency of washing as a means of further dissociating the two activities, and by the finding that the distribution of rhodanase among all isolated fractions is identical, within experimental errors, to that of cytochrome oxidase[1].

More recent investigations have led to the identification of two additional enzymes resembling acid phosphatase in all their cytological properties, namely, β-glucuronidase and cathepsin, both of which had already been shown to be concentrated in the mitochondria fraction, by Walker[6] and by Maver and Greco[7], respectively. Not only do these enzymes follow acid phosphatase closely during centrifugation, but they also exhibit its other peculiar properties. Like acid phosphatase, they have little activity towards their respective substrates (phenolphthalein glucuronide and hæmoglobin) when the intact granules are incubated during a short time at 37° and *p*H 5 in a medium made isotonic with sucrose. They are also released in soluble form and simultaneously activated when the granules are disrupted in the Waring blendor, frozen and thawed several times, or exposed to hypotonic media or to salt solutions. These properties had already been noted by Walker[6] in the case of β-glucuronidase. When the activating procedure is graded so as to release only part of the enzymes, all three are liberated in the same proportion. An integrated picture of all these results is shown in Fig. 1.

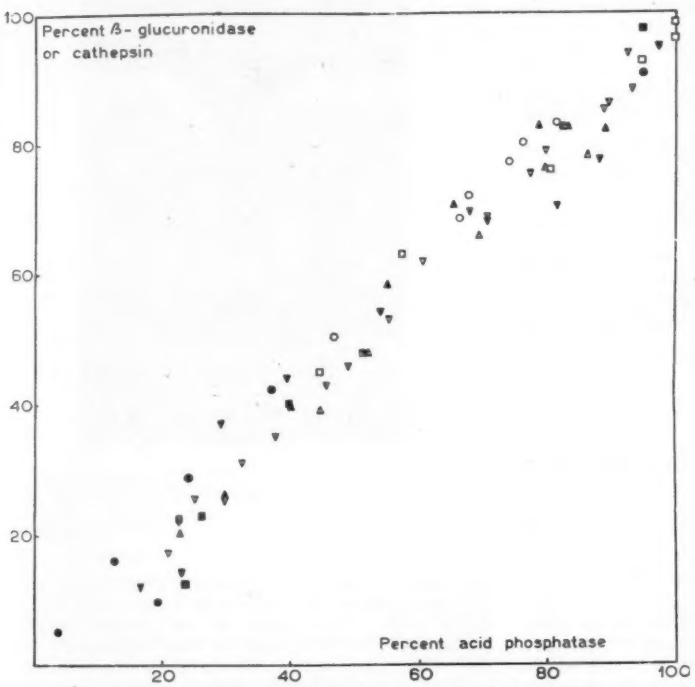

Fig. 1. Correlation between β-glucuronidase, cathepsin and acid phosphatase. White signs: β-glucuronidase; black signs; cathepsin.
Circles: Total activity of fractions isolated by differential centrifugation, as percentage of activity of homogenate.
Squares: Free activity of washed granules treated for various times in the Waring blendor, as percentage of total activity of the preparation.
Upward triangles: Same as above, but with granules frozen and thawed a number of times.
Downward triangles: Same as above, but with granules exposed to sucrose solutions of varying hypotonicity.
Total activities measured on completely disrupted preparations; free activities determined in 0·25 *M* sucrose, during 10 min.

These findings afford strong support to the theory outlined above that there are two distinct classes of large granules, having a different but homogeneous enzymic content. They also strengthen the osmotic interpretation given in earlier papers[2-4], according to which acid phosphatase is retained within the granules by a semi-permeable membrane having a low degree of permeability to its substrate, for it is now found that three different proteins are released in the same proportion when the preparation is subjected to partial damage. Finally, the fact that the same percentage of all three enzymes is found in free form in homogenates furnishes additional support to the opinion, already expressed in the case of acid phosphatase[2,3], that the enzymes are entirely bound to particles in the intact cell.

The cytological nature and function of these granules raise

intriguing problems. Judging from their sedimentation properties, they resemble mitochondria rather than microsomes, and cannot belong to the latter class, since they can be separated to a large extent from glucose-6-phosphatase, a typical microsomal enzyme[8]. They are not specially concentrated either in the poorly sedimented 'fluffy layer', which is found on top of the mitochondrial precipitate and which has been studied by several authors[5,9,10]. So far as can be judged at the present time, they could even form a small proportion of the total number of granules present in the mitochondria fraction, which would make their cytological identification very difficult.

In view of these observations, the significance of results indicating that a given enzyme is concentrated in the mitochondria fraction must remain uncertain, as long as it has not been identified as belonging to one or the other of the two classes of granules described in this communication.

A detailed account of these experiments will be submitted for publication in the *Biochemical Journal*. They have been supported by grants from the Centre National de Recherches sur la Croissance normale et pathologique, the Lilly Research Laboratories and the Rockefeller Foundation.

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Giant Condensation Nuclei from Bursting Bubbles

Among cloud physics workers there is increasing recognition that the larger of the salt nuclei that are found in the air may initiate rain by coalescence in clouds. Hence mechanisms which produce these nuclei at ocean surfaces are of special interest. Köhler[1] has suggested that they result from spray formed by the action of strong winds on wave crests. More recently, Aliverti and Lovera[2] have related the production of minute salt particles to the presence of bursting bubbles at the sea surface, and Facy[3] has suggested that the particles result from the shattering of the thin water-films present in clusters of bubbles.

At the Woods Hole Oceanographic Institution, high-speed motion pictures (more than 3,000 frames sec.$^{-1}$) of small bubbles bursting at the water surface have revealed one of the processes which bring about the formation of the larger salt nuclei. Fig. 1 illustrates some of the stages in the collapse of small bubbles and the production of jets, and Fig. 2 shows a jet producing droplets. Smaller bubbles are observed to form jets more rapidly and to eject much smaller droplets into the air. The bubble cavities and jets observed are similar in form to some of Worthington's 'splashes'[4], and confirm Stuhlman's[5] assumption that jets are formed by small bubbles bursting at the surface of distilled water.

Each bubble ejects about five droplets, the heights of projection ranging from about 0·5 to 15 cm.

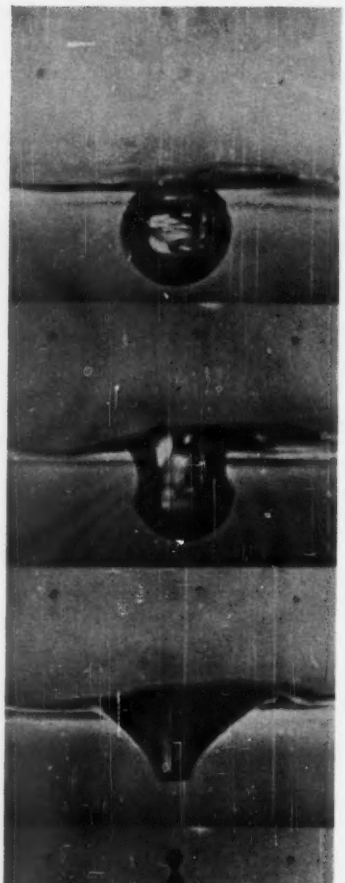

Fig. 1. Composite photograph of high-speed motion pictures illustrating some of the stages in the collapse of small bubbles and the formation of jets. Time interval between top and bottom frames about 2·3 milliseconds. Bubble diameter, 1·7 mm.; angle of view horizontal through glass wall. (Surface irregularities due to meniscus.)

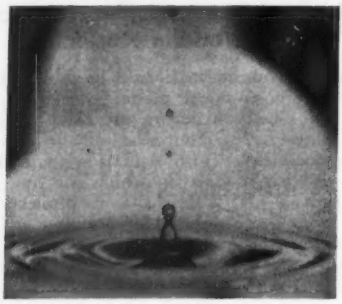

Fig. 2. Oblique view of jet from 1·0 mm. diameter bubble. Diameter of smallest droplet shown, 0·09 mm. Exposure time, 30 μsec.

Photographic studies have been made of bubbles ranging in size from 0·2 to 0·02 cm. diameter, though smaller bubbles are also observed to form jets and droplets. When bubbles burst in sea water, evaporation of the water from the droplets formed by the jets is observed to leave a salt residue which in many cases is similar in weight to salt nuclei found in the atmosphere. It is inferred that many of the larger sea-salt nuclei found in the atmosphere[6] originate in this manner from bubbles naturally formed in surface waters of the seas.

More complete information about this photographic study of bursting bubbles is to be published in the near future.

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Density of Deposited Carbon

MANY gaseous compounds of carbon, when passed over a heated surface, deposit on it elemental carbon, the form of which depends on the temperature of the surface[1].

We have deposited coatings of carbon 1–2 mm. thick on graphite rods. The densities of the deposits were determined using a flotation technique. The depositions were carried out using a closed vessel containing methane at an initial pressure of approximately 15 cm. mercury, in which a graphite rod 5 mm. in diameter was raised to the desired temperature by resistance heating, and maintained at this temperature until the pressure became constant.

The variation of the density of the coating obtained with the temperature of deposition is shown in Fig. 1. The maximum density found was 2·22 gm./cm.^{3}; this approaches closely the theoretical lattice density[2] of 2·265 gm./cm.^{3}.

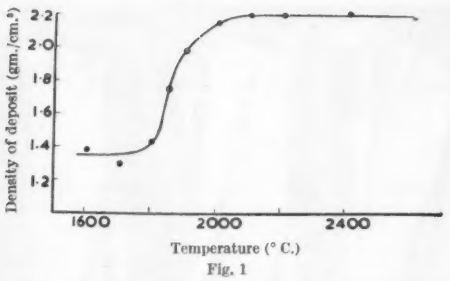

Fig. 1

Variation of the initial pressure of the methane at the lower temperatures was also investigated, and the preliminary results are shown in Fig. 2.

Summarizing the results, it may be stated that the density of the carbon deposited from methane at an initial pressure of 15 cm. attains a maximum value approximating to the theoretical density of graphite as the temperature of deposition is increased, and probably a lower limiting value as the temperature is lowered. Further, at a given temperature, the density of the deposit increases with increase of initial pressure of methane.

X-ray examination shows that the high-density deposits consist of sheets of graphitic carbon the *c*-axes of which are aligned approximately normal to the surface of the original rod, but which are otherwise randomly oriented. A deposit of lower density showed a similar structure with less pronounced alignment, but also contained material which was apparently not graphitic in structure.

The microstructure of the deposits was investigated using normal metallographic techniques, and is shown in Figs. 3 and 4. No differences between the high- and low-density deposits have been detected microscopically.

Preliminary measurements of electrical resistivity at room temperature indicate considerable variation of the specific resistance with density. The specific resistance of the high-density deposits measured parallel to the axis of the original rod was of the order 35×10^{-5} ohm cm. It therefore falls between that for natural graphites[3], 39–60 $\times 10^{-4}$ ohm cm., and that for commercial graphites[4], 65–120 $\times 10^{-5}$ ohm cm. The grain boundaries visible in Figs. 3 and 4 may be the cause of the high resistance as compared with natural graphite.

Such variations as have been detected may be of considerable importance when considering both the fundamental properties of deposited carbon, for example, chemical reactivity, and its technical applications. Many workers[5] have used carbon filaments coated with material deposited from hydrocarbons at high temperatures and low pressures to

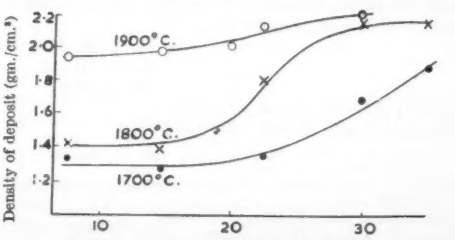

Fig. 2

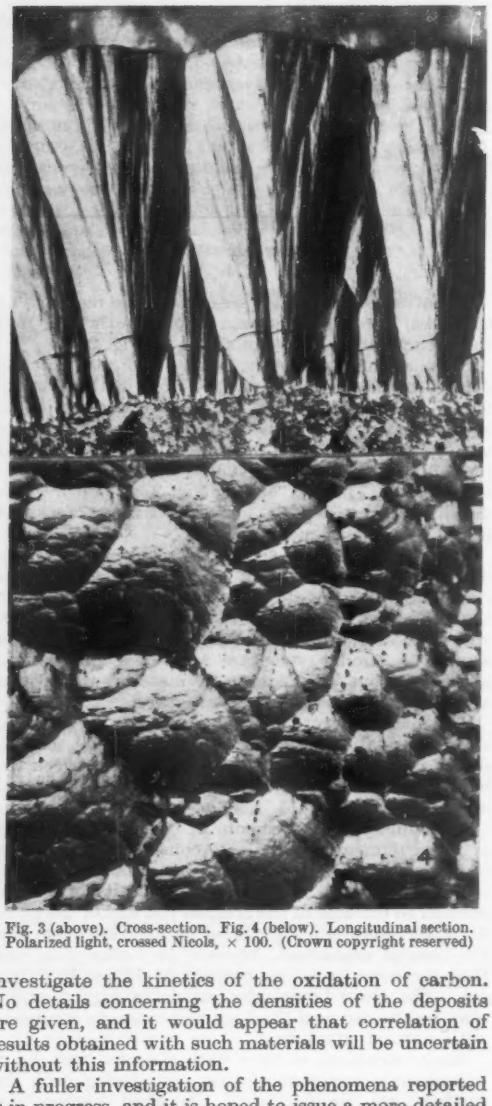

Fig. 3 (above). Cross-section. Fig. 4 (below). Longitudinal section. Polarized light, crossed Nicols, × 100. (Crown copyright reserved)

investigate the kinetics of the oxidation of carbon. No details concerning the densities of the deposits are given, and it would appear that correlation of results obtained with such materials will be uncertain without this information.

A fuller investigation of the phenomena reported is in progress, and it is hoped to issue a more detailed account at a later date.

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Experimental Data and Model Structures for the Insulin Molecule

Two recent communications[1,2] have described the results of stereochemical model studies of insulin based on the α-helix structure and using the detailed amino-acid residue sequences established by Sanger and his associates[3]. Both studies were made using identical packing models[4] in which the fundamental residue unit (—NH.CH(*R*).CO—) dimensions are different from those derived by Pauling and Corey[5] from experimental studies of amino-acid and peptide structures. The cystine residue bond-lengths and bond-angles recorded by Arndt and Riley[2] differ markedly from those found by Yakel and Hughes[6] in N.N′-diglycyl-L-cystine. While local deviations in bond-lengths and bond-angles of the residue units and of the hydrogen bonds, brought about by side-chain (*R*) group interactions, may perhaps be expected along the peptide chain of a native protein, the overall use of dimensions which differ considerably from the experimentally derived values appears to be a purely arbitrary procedure.

The α-helix structure may exist in insulin; it is certainly an attractive possibility since the α-helix is energetically the most stable polypeptide chain configuration, and has been shown to occur in synthetic polypeptides. Further, the X-ray scattering curve[7] from powdered insulin appears closely comparable to the radial distribution function for a mixture of left-handed (L) and right-handed (R) α-helices. X-ray studies[8] of the vector structure of air-dried acid insulin sulphate crystals strongly suggest that the molecule is made up of parallel coiled (or folded) polypeptide chains with parallel close-packed intermolecular association, oriented along the *a*-axis. The length of the *B*-chain of insulin coiled in an α-helix is approximately 44 A., the length of the *a*-axis. The maximum cross-section area for each close-packed chain is 12·85 A. × 7·6 A.; thus, in order to give a reasonable value for the partial specific volume of insulin, an average unit residue translation along the chain of approximately 1·5 A. is required.

The chains in insulin are linked together by —S—S— bonds. In an earlier scale-model study[9] of the insulin structure using van der Waals packing models and the Pauling–Corey α-helix, attempts were made to describe all the ways in which four ($2A+2B$) or two ($A+B$) chains could be joined together by cystine linkages. The study was restricted to structures with either all L- or all R-helices. The chains were required to be parallel to each other and at a minimum interchain distance of approximately 10 A. Intra-chain cystine linkages between the 6 and 7 or 7 and 11 *A* chain positions were not possible and this appeared to eliminate the two-chain model. At that time it appeared that only two (namely, 2L or 2R) four-chain structures were possible, both linear arrays one chain thick. A single-row model is difficult to accommodate in the unit cell and cannot form a close-packed array unless the asymmetrical unit is the two-chain ($A+B$) structure. The details of the vector structure and the packing limitations imposed by the geometrical relationship between rhombohedral zinc insulin and acid insulin sulphate crystals both strongly suggest the the four-chain unit is close-packed. Two acceptable close-packed arrays have been suggested[9b], shown (in cross-section) diagrammatically below, where the *A*- and *B*-type chains are represented by ellipses of different eccentricities:

In a more recent study, completely rigid wire models of the Pauling–Corey[5b] α-helix were prepared. Only the half cystine —(β)C—S— residues were attached and these had the dimensions suggested by the N.N′-diglycyl-L-cystine[6] study. These models increased the number of formally possible four-chain structures to the twelve single-row models described by Robinson[3], and confirmed the conclusion that two-chain structures could not be formed. If small cumulative changes in the helical angle are permitted, close-packed four-chain α-helix structures may be possible. The Arndt and Riley insulin models cannot be set up with the detailed dimensions of the Pauling–Corey α-helix structure.

From the studies of Harfenist and Craig[10], it now appears very probable that the four-chain 'molecule' is a dimeric association of two 5,733 molecular weight $(A+B)$ monomers. If this is so, and the chains are not folded back on themselves, there must be an A_{7-11} intra-chain cystine linkage. Such a bond cannot be formed either with the 3·6 α-helix or with a 3·9 helix (1·4 A. translation per unit residue) based on the Pauling–Corey dimensions. To maintain the α-helical configuration in the A_{7-11} region with an intra-chain —S—S— linkage involves extensive linear (>0·1 A.) and angular (>10°) distortions of bonds in both the backbone peptide chain and the cystine linkage. If a transition from α- to π-helix through a bifurcated hydrogen bond should take place at both boundaries of the A_{7-11} region, the distortions involved in forming an intra-chain —S—S— bond would be minimized. The α-helix may not occur at all in insulin or, in certain regions of the chain, disordered non-residue equivalent configurations may exist. The model study does show that a two-chain classical α-helix model is not wholly acceptable, and serves to emphasize that in a naturally occurring polyfunctional peptide chain the side-chain groups must control to a very large extent the detailed local-chain configuration.

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Equations of Motion for Continuous Matter of Special Relativity in the Lagrange Variables

THE equations of motion for continuous matter of special relativity are usually[1] deduced by equating to zero the divergence of the material energy (the 'Minkowski') tensor:

$$\rho v_\mu v_\nu + \delta_{\mu\nu} p, \qquad (1)$$

where ρ is the rest density and p is the pressure supposed given as a function of the x_μ. v_μ means $\mathrm{d}x_\mu/\mathrm{d}s$. In this way we get the equation of continuity:

$$\frac{\partial \rho v_\mu}{\partial x_\mu} + \frac{\mathrm{d}p}{\mathrm{d}s} = 0. \qquad (2)$$

$\mathrm{d}p/\mathrm{d}s$ is considered small and is usually ignored; in fact, it represents the action of the pressure in creating matter[2]. We further get for the equations of motion (ignoring $\mathrm{d}p/\mathrm{d}s$):

$$\frac{\partial v_\mu}{\partial x_\nu} v_\nu + \frac{1}{\rho}\frac{\partial p}{\partial x_\mu} = 0. \qquad (3)$$

These equations may be called the Euler equations, since the first three equations in (3) are the Euler equations of classical hydrodynamics.

What may be called the Lagrangian equations of special relativity may be deduced from the stationary principle:

$$\delta \int L \, \mathrm{d}^4x = \delta \int \{\rho(v_\mu v_\mu)^{1/2} - p\} \, \mathrm{d}^4x = 0. \qquad (4)$$

Here the position of the particle of matter is denoted by y_μ, and v_μ means $\mathrm{d}y_\mu/\mathrm{d}s$. The x_μ now constitute an arbitrary frame of reference. It is necessary to assume separately the Lagrangian equation of continuity. This is done by thinking of the matter as contained in a portion of a space-like surface which has been parametrized by three parameters u_1, u_2, u_3, and the equation of continuity is then:

$$\rho\Gamma = \rho_1\Gamma_1, \qquad (5)$$

where $-\Gamma^2$ is the determinant $\left|\frac{\partial y_\mu}{\partial u_r}\frac{\partial y_\mu}{\partial u_s}\right|$, and $\rho_1\Gamma_1$ is the value of $\rho\Gamma$ at some initial time. The variation of the integral (4) gives the equations of motion:

$$\frac{\mathrm{d}v_\mu}{\mathrm{d}s} + \frac{1}{\rho}\frac{\partial p}{\partial y_\mu} = 0. \qquad (6)$$

These are obviously the Lagrangian equations in relativistic form.

Equations (6) can, however, also be written:

$$\frac{\partial v_\mu}{\partial y_\nu} v_\nu + \frac{1}{\rho}\frac{\partial p}{\partial y_\mu} = 0,$$

which are the same as (3). Hence the distinction between the Lagrange and the Euler variables disappears in four dimensions.

The confusing relation:

$$\frac{Dv_k}{Dt} \equiv \frac{\partial v_k}{\partial t} + \frac{\partial v_k}{\partial x_r} v_r = \frac{\mathrm{d}x_k}{\mathrm{d}t},$$

between the Euler velocity and the Lagrange velocity of classical hydrodynamics now becomes clearer. The 't' of the Lagrange variables is really the proper time s.

There is also an interesting relationship between the Euler equation of continuity $\partial\rho v_\mu/\partial x_\mu = 0$ and the Lagrange equation $\rho\Gamma = \rho_1\Gamma_1$. They are just the two sides of Gauss's theorem applied to a small four-dimensional volume.

The discrepancy between (6) and (3) which arises, if the term dp/ds in (2) is not neglected, is easily remedied by allowing for the creation of matter by the action of pressure in the Lagrange equation of continuity (5) also, by writing it:

$$\rho\Gamma\, d^2u - \rho_1\Gamma_1\, d^2u + \int_{V(\Gamma d^2u)} \frac{dp}{ds}\, d\tau = 0.$$

The volume integration is over the four-dimensional volume swept out by the area Γd^2u.

A detailed account of the above results together with a discussion of the relationship between the Minkowski tensor and canonical tensor deduced from the Lagrangian used in (4) will be published elsewhere. I thank Prof. P. A. M. Dirac for his interest in this work.

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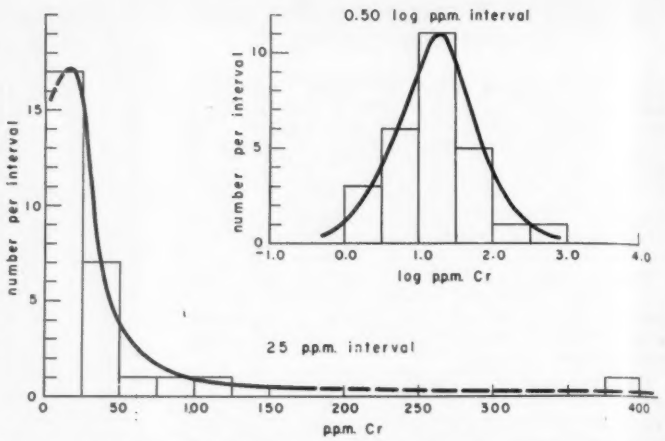

Fig. 1. Chromium in Canadian granite. Distribution of chromium content shows extreme positive skewness whereas the (log) content is normally distributed. Dispersion is large ($C > 150$ per cent)

A Fundamental Law of Geochemistry

The late V. M. Goldschmidt defined one principal task of geochemistry as being, "to find the laws of distribution of the elements". One such law may apparently be found by close scrutiny of fully quantitative determinations of many elements in a comparatively large number of specimens of some specific rock or mineral type.

The determinations of potassium, rubidium, scandium, vanadium, cobalt, gallium, chromium and zirconium in diabase (Fairbairn, Ahrens and Gorfinkle[1]) and potassium, rubidium, cæsium, lead, scandium, vanadium, cobalt, chromium and zirconium (Ahrens[2]), molybdenum (Sandell[3]) and fluorine (Seraphim[4]) in granite have been examined statistically, and the conclusions reached are: first, frequency distribution plots of the usual type (for example, Fig. 1) assume a decided positive skewness when the dispersion of an element is large—hence, distribution is not normal although it may appear to be so for those elements which show small dispersion (for example, Fig. 2); secondly, distribution becomes normal in all examples, irrespective of the magnitude of the dispersion, when concentration (the variate) is transformed to log concentration (see Figs. 1 and 2). As the total number of observations is reasonably large (812) and as they refer to a variety of distinctly different elements, the following fundamental geochemical law concerning the nature of the distribution of elements may be enunciated with some confidence:

the concentration of an element is lognormally distributed in a specific igneous rock.

It follows directly from this law that the abundance (arithmetic mean or average) of an element is always greater than the most prevalent concentration, which in a lognormal distribution is given by the geometric mean. The difference is determined solely by the magnitude of the dispersion. In the above examples, the abundance and most prevalent concentration of rubidium are virtually identical, whereas the abundance of chromium (40 p.p.m.) is more than twice its most prevalent concentration (17 p.p.m.).

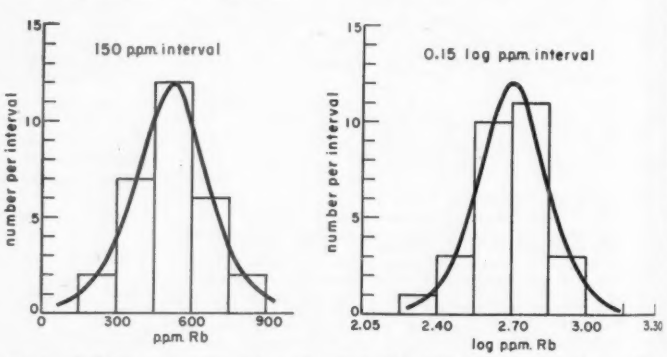

Fig. 2. Rubidium in New England granite. Both the rubidium content and its logarithm appear normally distributed. Dispersion is small ($C = 28$ per cent)

A full discussion will be published elsewhere.

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Synthesis of Sucrose by a Plant Enzyme Extract

An enzyme capable of sucrose synthesis has been prepared from dried cells of the bacterium *Pseudomonas saccharophila*[1]. This enzyme, sucrose phosphorylase, catalyses the reversible reaction

$$\text{glucose-1-phosphate} + \text{fructose} \rightleftharpoons \text{sucrose} + \text{inorganic phosphate.}$$

The equilibrium constant for this reaction

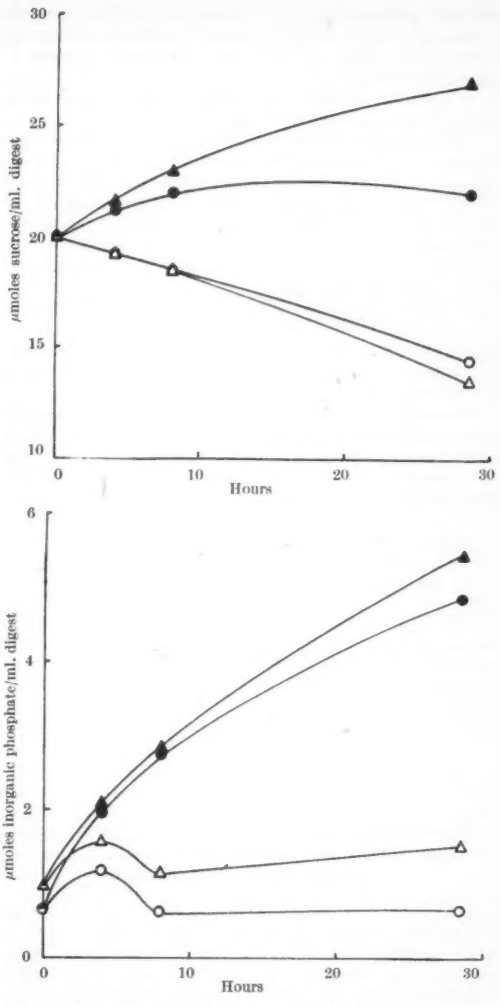
$$\left(K = \frac{[\text{sucrose}]\,[\text{inorganic phosphate}]}{[\text{glucose-1-phosphate}]\,[\text{fructose}]}\right)$$

is 0·05 at *p*H 6·6 and 30° C.[2]. Attempts to demonstrate a sucrose phosphorylase in various plant tissue extracts have been unsuccessful[3].

In the present investigation it was found that when crude extracts from peas were incubated with a mixture of glucose-1-phosphate and fructose there was a liberation of inorganic orthophosphate and a synthesis of a sugar possessing the properties of sucrose. This sugar was indistinguishable from sucrose when applied to paper chromatograms and developed in the following solvents: *n*-propyl alcohol (80 vol.)/water (15 vol.)/ammonia (5 vol.), *n*-butyl alcohol (40 vol.)/acetic acid (10 vol.)/water (50 vol.), *n*-butyl alcohol (50 vol.)/ethyl alcohol (5 vol.)/water (10 vol.) and ethyl acetate (57 vol.)/*n*-propyl alcohol (32 vol.)/water (13 vol.). The substance reacted strongly to benzidine-trichloracetic acid spray[4] and to naphthoresorcinol-phosphoric acid spray[5], indicating that it contained both aldose and ketose components. The sugar, when eluted from chromatograms, did not reduce Fehling's solution but was completely hydrolysed by 0·025 *N* hydrochloric acid within four minutes at 100° C. and was then strongly reducing. The hydrolysed material, when applied to paper chromatograms and developed in each of the four solvents previously mentioned, was shown to contain two components which ran in positions identical with those occupied by glucose and fructose and which gave the reactions expected from these monosaccharides when sprayed with the benzidine and naphthoresorcinol reagents.

The effects of the addition of fructose and of glucose-1-phosphate on the sucrose and inorganic phosphate content of enzymic digests containing the crude pea extract are shown in the accompanying figure. Sucrose was determined by estimating the fructose component in the sucrose separated on paper chromatograms. The crude pea extract contained sucrose. Without addition of substrate, the sucrose concentration in the enzymic digest decreased, and this decrease was slightly greater when glucose-1-phosphate was added. When fructose alone was added there was a small increase in sucrose (the crude pea extract contained significant amounts of hexose phosphates). On the addition of both fructose and glucose-1-phosphate, the sucrose content was considerably increased. Fructose also produced a liberation of inorganic phosphate in digests with and without glucose-1-phosphate.

It will be seen from the data presented in the figure that the addition of glucose-1-phosphate increased the difference in sucrose concentration between enzymic digests with and without fructose from 7·5 to 13·5 μmoles/ml. after twenty-eight hours but decreased the difference in inorganic phosphate concentration between such digests from 4·2 to 3·9



The effects of glucose-1-phosphate and fructose on sucrose and inorganic phosphate concentration in enzymic digests containing the crude pea extract. Digest: crude pea extract, 2 ml.; total volume, 4 ml. *p*H 6·9, 25° C. Additions: glucose-1-phosphate, 0·013 *M*; fructose, 0·055 *M*. ○, No addition; ●, fructose; △, glucose-1-phosphate; ▲, glucose-1-phosphate plus fructose

μmoles/ml. It was further found that increasing the initial concentration of glucose-1-phosphate in the enzymic digests from 0·013 *M* to 0·033 *M* increased the liberation of inorganic phosphate on the addition of fructose but depressed the formation of sucrose. It appears that there is no direct relationship between the amounts of sucrose formed and inorganic phosphate liberated by the crude pea extract.

It was found that while the concentration of sucrose was increasing in the enzymic digest containing both glucose-1-phosphate and fructose, the value of the expression

$$\frac{[\text{sucrose}]}{[\text{glucose-1-phosphate}]}\,\frac{[\text{inorganic phosphate}]}{[\text{fructose}]}$$

increased from approximately 2·0 at eight hours to approximately 2·8 at twenty-eight hours. These values were minimal, as will be shown in a sub-

sequent publication. The conclusion is that a mechanism of sucrose synthesis was operating which was different from the simple reaction between glucose-1-phosphate and fructose shown in the equation. This is in agreement with the results of previous workers using intact leaves[6] and algæ[7].

The sucrose-forming activity of the crude pea extract was destroyed by heating for three minutes at 100° C. The activity remained in the supernatant when the crude pea extract was centrifuged at 20,000 *g* for thirty minutes. The extract possessed negligible invertase activity. Sucrose synthesis was completely inhibited by 1×10^{-4} *M* iodoacetate and $6{\cdot}5 \times 10^{-3}$ *M* fluoride.

A detailed account of this work will be presented elsewhere. It is proposed to publish shortly results of experiments using a purified enzyme preparation.

I wish to express my indebtedness to Prof. C. S. Hanes and Dr. L. W. Mapson.

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Autoradiographic Detection of Sulphur-35 Synthesis by the Mucous Neck Cells of the Rat's Stomach

Tinctorial and histochemical differences between the surface cells of the stomach and the mucous neck cells described by Bensley are now classical knowledge[1]; moreover, physiological and biochemical differences between dissolved mucin and visible mucin have been established[2]. The stomach secretion has also been found to contain a mucoprotein, the polysaccharide moiety of which was identified as mucoitin disulphuric acid[3,4].

While studying the formation of the organic matrix of bones and teeth by autoradiographic mapping, some interesting pictures of the stomach were revealed after introduction of radiosulphur. Rats of 10 days of age were injected subcutaneously with a tracer dose of sulphur-35 separated isotope in the form of weak sulphuric acid, and they were sacrificed at various intervals thereafter. The tissues were fixed in a mixture of 95 per cent ethanol and neutral formaldehyde (3/1). After routine histological treatment, sections were cut and coated with fluid photographic emulsion to obtain autoradiographs by the inversion technique[5].

In animals sacrificed one hour after the injection of sulphur-35, the stomach wall showed a fairly high Geiger–Müller count compared to other soft tissues. Autoradiographs exposed for a few days (Fig. 1) have revealed that there was a specific localization of the radiosulphur in the glandular portion of this organ,

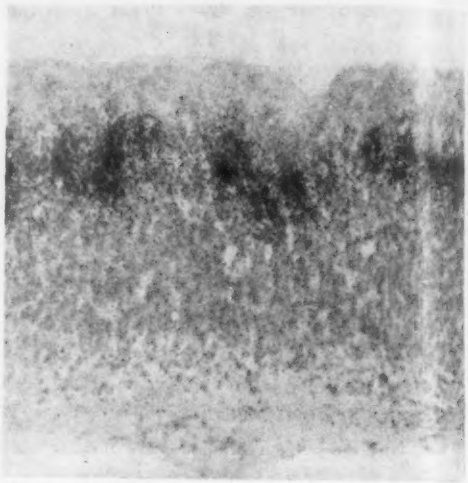

Fig. 1. Sulphur-35 autoradiograph of a portion of the mucosa of the glandular stomach in a 10-day old rat, showing the presence of radiosulphur in the mucous neck cells 1 hr. after a subcutaneous injection. × 332

at the level of the neck of the glands. The surface epithelium as well as the distal portion of the glands showed no autoradiographic image. In animals sacrificed 48 hr. after the introduction of tracer, no autoradiographic picture was visible over the mucosa; but streaks of mucin mixed with the chyme of the cavity exhibited radioactivity.

These experiments indicate that there is a chemical difference between the secretion of the surface cells and that of the mucous neck cells. These have the ability to synthesize rapidly an organic substance containing sulphur and retained by alcohol–formaldehyde fixation. Boström and Odeblad[6] have recently demonstrated that, following an injection of radiosulphate, the uptake of sulphur-35 is highest in structures containing mucopolysaccharides. It is thus reasonable to conclude that the mucous neck cells produce a mucoprotein containing a sulphomucopolysaccharide, and that in comparable circumstances this substance is not present in the surface cells. The product of the mucous neck cells is totally excreted at the end of two days, and it is found in the chyme where it retains its identity after histological fixation. Work is in progress to establish comparisons between the various portions of the stomach and other regions of the gastro-intestinal tract.

I am indebted to Mrs. Cécile Bélanger for technical collaboration, and to the Medical Division of the National Research Council of Canada for a grant-in-aid. The radioactive material was provided by Atomic Energy of Canada, Ltd.

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Effect of Hydroquinone on Mitosis

In a previous communication, Parmentier and Dustin[1] reported a mitotic anomaly in the mouse intestine produced by hydroquinone. The characteristic feature of this was the so-called 'three-group metaphase', comprising a normal metaphase plate with additional chromosome particles or groups at each pole of the spindle. One of the authors afterwards described the same phenomenon in the intestine and bone marrow of the golden hamster[2]. According to the latter, characteristic 'three-group metaphases' may also be produced in the rat, whereas "the guinea pig, the chick and chick fibroblast cultures were not responsive as regards this effect".

We wish to report analogous effects produced by hydroquinone *in vitro* in chick fibroblasts, and *in vivo* in the liver, the bone marrow and the cornea of the rat.

Chick fibroblast cultures (third passage) were immersed in a solution of 1 in 10^{-6} hydroquinone in Ringer's solution and incubated for one hour, or immersed in a solution of 1 in 10^{-7} and incubated for 2 hr. The whole cultures were then fixed and stained with Giemsa's stain. Typical hydroquinone mitoses could be observed (Fig. 1).

In rats treated intraperitoneally with the same doses as used by Parmentier and Dustin, we observed, 2 hr. after treatment, mitoses in the liver, some showing the characteristic features (Fig. 2) as described by these authors. In the bone marrow the 'three-group mitoses' were found in the white precursors (Fig. 3), whereas the red precursors showed often very marked karyorrhexis. As in the cultures, only a certain number of mitoses showed these changes, others being normal. On the whole, mitoses were not very numerous in the bone marrow after treatment with hydroquinone.

In the cornea of the rat the same effect was seen 2 hr. after instillation of one drop of a 5 per cent solution of hydroquinone into the conjunctival sac, or after intraperitoneal injection of hydroquinone in doses mentioned above.

These observations, added to those of Parmentier and Dustin, show that hydroquinone had a general effect on various tissues, manifested by characteristic changes in the morphological aspect of mitosis. The experiments on chick fibroblasts *in vitro* and on the cornea of the rat *in vivo* further suggest that the drug acts directly on the cell.

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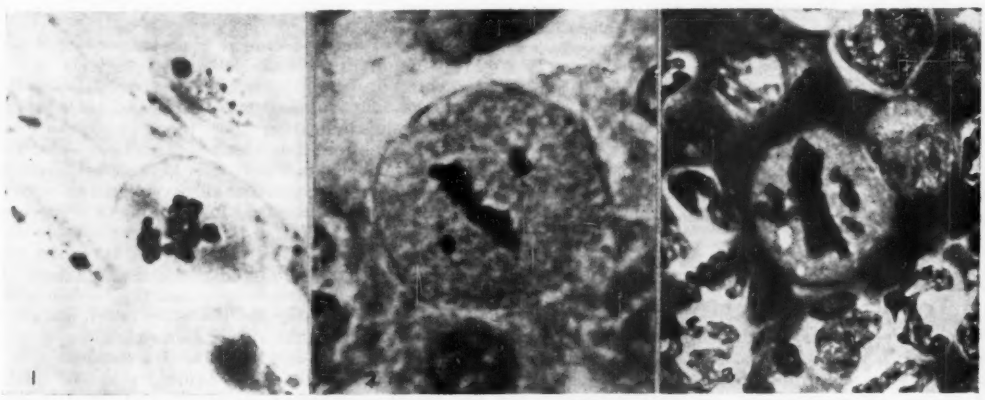
Application of Nigrosine to the Study of the Salivary Chromosomes

In this work, an alcohol-soluble nigrosine (Edward Gurr) was used, and the stain prepared by Rosen's method[1,2]. The scheme of treatment followed for staining the salivary chromosomes of *Drosophila* is as follows. (1) Dissection in 45 per cent acetic acid. (2) Treatment with freshly prepared alcoholic hydrochloric acid during 1–2 min., keeping the glands well covered. (3) The specimen is washed two or three times carefully with distilled water, and a big drop of water is left on the material for 5 min. (4) Drain thoroughly and carefully. (5) Add a drop of stain and put on a cover slip, without squashing. (6) After 10–15 min., squash under blotting paper and immediately put a big drop of glycerine on one edge of the cover slip. (7) The preparation can be studied at once; but after 24 hr., the glycerine having penetrated the specimen thoroughly, it is convenient to get rid of excess liquid and make a wax border. Preparations thus obtained last a long time if handled carefully.

With this method the salivary chromosomes are strongly and specifically coloured. Only the outer bands are dyed, except in the heterochromatin regions. But when the preparation is ageing, the interbands become faintly coloured, and the same happens with the cytoplasm.

The greatest interest of this method is in its peculiar mode of placing the chromocentre. In every case studied the chromocentre shows itself as a differentiated and constant structure for each species. Four structural elements can be distinguished: (1) faint



(1) Typical three-group metaphase in chick fibroblast *in vitro* (Giemsa). × 1,600
(2) The same type of mitosis in liver cell of rat (H.E.). × 1,700
(3) The same in promyelocyte in bone marrow of rat (Giemsa). × 1,200

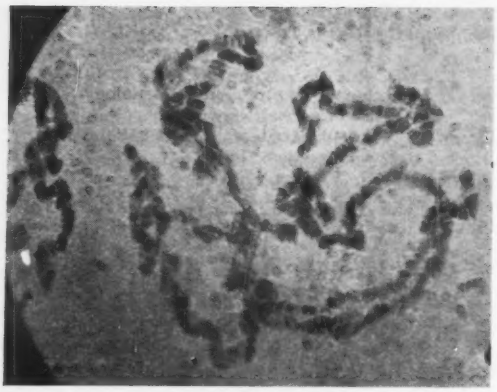


Fig. 1

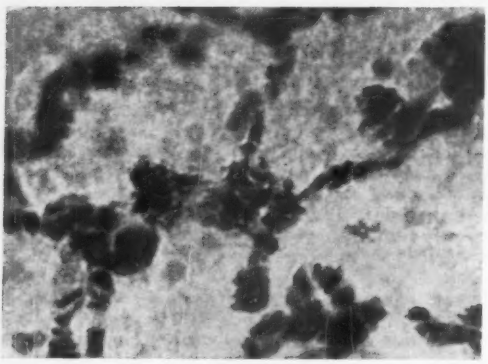


Fig. 2

heterochromatin with chromomeres; (2) faint heterochromatin without chromomeres; (3) compact heterochromatin with vesicle chromomeres; (4) heterochromatin with chromomeres arranged in more or less regular bands. Between (1) and (2) there is a whole series of gradations. In the material studied, these elements occur as follows: *D. funebris* (1), *D. immigrans* (1, 3, 4), *D. mercatorum* (1), *D. melanogaster* (2, 4) and *D. simulans* (2, 4).

The accompanying photographs are of the salivary nucleus of *D. funebris*, Fig. 2 being an enlarged view of the region of the chromocentre.

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Action of Duck's Egg White Ovomucoid on Tryptic Hydrolysis of Casein *in vitro*

It has been reported by Dikshit and Patwardhan[1] that duck's egg white has a low efficiency for promotion of growth in rats when compared with hen's egg white. On autoclaving, the nutritive value of duck's egg white showed remarkable improvement[2]. *In vitro* digestion of raw egg whites with trypsin indicated that the rate of hydrolysis of duck's egg white was much slower than that of hen's egg white. Ovomucoid prepared from duck's egg white according to the method of Lineweaver and Murray[3] exhibited both antitryptic activity and suppression of growth in rats when added to their diets. The possibility of interference by the ovomucoid with the enzymatic release of one or more essential amino-acids by trypsin was envisaged. This communication gives the results of a preliminary investigation on the hydrolysis of casein by trypsin in presence of the purified duck's egg white ovomucoid, which showed that the liberation of several essential amino-acids was inhibited.

2,500 mgm. of casein (lactic casein, 13·5 per cent nitrogen) in a phosphate buffer of *p*H 7·6 was digested with 100 mgm. of trypsin (Nutritional Biochemicals) at 37° C. One such batch served as the control, and to another 25 mgm. of duck's egg white ovomucoid was added. Aliquots were withdrawn at the end of 24 and 120 hr.; trypsin was inactivated by heating in boiling water for 15 min. Undigested protein was precipitated by adjusting the *p*H to 4·2 with a few drops of glacial acetic acid. In duplicate aliquots withdrawn at the same time, total amino-nitrogen was determined by formol titration.

In the protein-free filtrate all the essential amino-acids except methionine were estimated by microbiological methods as described by Dunn *et al.*[4]; methionine was estimated by the colorimetric method of McCarthy and Sullivan[5]. The results are given in Table 1.

Table 1. Essential Amino-Acids liberated from Casein by Trypsin with and without Duck's Egg White Ovomucoid

Amino-acid	Amino-acid liberated (mgm.) after: 24 hr.			120 hr.		
	Control	Exp.	Percentage deficiency in exp.	Control	Exp.	Percentage deficiency in exp.
Arginine	105·0	95·0	9·5	105·0	100·0	4·8
Histidine	52·0	25·0	51·9	61·0	42·0	31·2
*iso*Leucine	103·9	79·2	23·8	107·9	84·2	22·0
Leucine	284·5	199·1	30·0	289·7	208·6	28·0
Lysine	106·5	52·5	50·7	112·5	77·5	31·1
Methionine	77·0	77·0	nil	77·6	75·2	3·1
Phenylalanine	135·0	123·4	8·6	136·7	131·7	3·7
Threonine	77·2	38·7	49·9	77·2	41·3	46·5
Tryptophan	40·0	35·0	12·5	40·0	40·0	nil
Valine	100·0	26·5	73·5	111·0	53·0	52·2

The total amino-nitrogen liberated was 99·4 and 113·0 mgm. in 24 and 120 hr. respectively in the control. In the presence of the ovomucoid, the corresponding values were 67·4 and 85·8 mgm. respectively, indicating that the presence of ovomucoid inhibited the release of amino-acids. The percentage deficiency of the liberated individual amino-acids in the presence of ovomucoid calculated over the amounts released in the control is given in columns 4 and 7. It can be seen from the table that enzymatic release of histidine, lysine, threonine and valine was highly inhibited; the inhibition in the liberation of *iso*leucine, leucine and tryptophan (after 24 hr.) was moderate. On the other hand, liberation of arginine, methionine, phenylalanine and tryptophan (after 120 hr.) was not significantly retarded.

From these results, it is evident that the duck's egg white ovomucoid interferes with the *in vitro* release of certain essential amino-acids by trypsin, from which it would be reasonable to conclude that the presence of ovomucoid may create an unbalance

of amino-acids in the body owing to its selective inhibition of the liberation of amino-acids in the intestines. Geiger[6] suggested that the availability of all the essential amino-acids from a protein in definite proportions in the intestines determines to a very large extent its effective utilization for tissue protein synthesis. The results of this investigation would appear to support Geiger's hypothesis and provide an explanation for the low nutritive value of duck's egg white.

Further work is in progress, and a detailed report will be published elsewhere. We are grateful to Dr. V. N. Patwardhan, director, Nutrition Research Laboratories, for his interest and advice in this investigation.

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Thelytokous Parthenogenesis for Four Generations in the Desert Locust (*Schistocerca gregaria* Forsk) (Acrididæ)

Parthenogenesis occurs naturally in several orders of insects, and can conveniently be classified according to the sex of the offspring which develop from the unfertilized egg: (1) arrhenotoky—males only (fertilized eggs give rise to females); (2) thelytoky—females only; (3) amphitoky—both sexes.

It is the second type which I believe occurs exclusively in the desert locust. Parthenogenesis of the thelytokous type has been recorded for many Acrididæ; for example, Plotnikov[1] for the migratory locust (*Locusta migratoria*), Slifer and King[2,3] for many species of grasshoppers. Nabours[4] with a ratio of 4,470 females to 7 males, and Nabours and Foster[5] recording all females, with rare exceptions, can be included in this type of parthenogenesis. Faure[6] unfortunately did not sex his brown locusts (*Locustana pardalina*), which were produced parthenogenetically. Husain and Mathur[7], working with *Schistocerca gregaria*, report several cases (four egg-pods) of parthenogenetic eggs; hoppers hatched from two egg-pods, and Husain and Mathur state that they were able to rear hoppers to the adult stage but failed to get a second generation. They found that their parthenogenetically produced locusts were males and females in equal numbers, that is, amphitokous parthenogenesis. These results of Husain and Mathur are entirely contrary to my findings, as all my parthenogenetically produced *Schistocerca gregaria* have been females.

Although all my locusts have been reared in cages, the parthenogenesis can still be regarded as 'natural' because they have been kept at a constant temperature of 90° F. (32·2° C.) and a relative humidity varying from approximately 60 to 70 per cent. These conditions have been shown by me[8] to be suitable for this species of locust. (A few experiments have now been carried out exposing the eggs to a temperature of 41° F. (5° C.) for 5 hr. within 24 hr. of being deposited, but this does not seem to affect the percentage hatched in any way.) The original females (Table 1), which were sexually produced, were separated from males while still in the hopper stage and housed in a separate insectary, so that there could be no possibility of copulation having taken place. Up to the date of writing, it has been possible to produce four successive generations of females; and these females have laid a total of 170 egg-pods.

Table 3. Rate of Development and Percentage of Parthenogenetically Produced Hoppers Reaching the Adult Stage

How produced	No. of hoppers at start of exp.	Average length of hopper life (in days)	Total number of adults	Sex of adults		% of hoppers which reach adult stage
				Males	Females	
F_1 Parthenogenetically	55*	30·1	18	—	18	32·7
F_2 ,,	52*	28·9	22	—	22	42·3
F_3 ,,	21*	29·5	11	—	11	41·7
F_4 ,,						
Controls	17*	Experiment still in progress				
Sexually	232	28·6	121	56	65	52·2

* These figures do not represent all hoppers produced parthenogenetically as many, not included here, were used for cytological work.

Table 1. Rate of Sexual Maturation, Length of Adult Life, and Fecundity of Parthenogenetic Females

How produced	No. of adults		First egg-pod (days)	Last egg-pod (days)	Av. egg-pods per female	Female days per egg-pod	Length of adult life (days)		
	♂♂	♀♀					Av.	Min.	Max.
Sexually*	0	10	35	320	5·4	33·7	182·1	97	328
F_1 Parthenogenetically	0	8	37	211	3·1	36·9	130·5	33	226
F_2 ,,	0	15	31	Experiment still in progress					
F_3 ,,	0	10	30	,, ,, ,,					
Controls									
Sexually	24	30	22	102	3·5	18·1	63·5	26	168

* This experiment has been repeated and a second series of parthenogenetically produced locusts started.

Table 2. Number of Eggs per Egg-pod, Number which Hatched, and Incubation Period of Parthenogenetically Produced Eggs

How produced	No. of egg-pods tested	Eggs per egg-pod			No. of hoppers which hatched per egg-pod			Eggs which hatched (per cent)	Incubation period (days)
		Av.	Min.	Max.	Av.	Min.	Max.		
F_1 Parthenogenetically	17	42·8	33	55	10·1	1	35	23·6	14·2
F_2 ,,	16	40·1	29	51	10·6	1	30	26·3	14·7
F_3 ,,	7	47·0	24	60	10·3	4	21	25·5	14·8
F_4 ,,									
Controls	2	41·3	31	55	11·5	3	20	27·8	14·5
Sexually	59	47·2	28	64	35·5	8	62	75·2	14·1

It can be seen from Table 1 that the interval between the emergence of the adults and the laying of the first egg-pod was much longer for all parthenogenetic generations (30–37 days) than for the controls (22 days). This suggests that either the presence of males in the cages, or copulation, has a stimulating effect on the rate of sexual maturation of the females. Likewise, more days per egg-pod (33·7–36·9) were required by the parthenogenetic females than by the controls (18·1 days). Notwithstanding this increase in the time required to produce an egg-pod, the total number of egg-pods per female was not affected, because the females producing parthenogenetically lived much longer than the controls producing fertilized eggs. This becomes even more obvious when it is noted that there is no significant difference in the incubation period (Table 2) or in the time required for hopper development (Table 3). The difference in the length of adult life of the two groups is so striking that it raises a very important physiological problem which obviously requires further study.

The average number of egg-pods produced parthenogenetically (also eggs per egg-pod) compares favourably with the number produced sexually, but the average hatch (Table 2) per egg-pod has been very much lower in all generations. So far the hatch for parthenogenetically produced egg-pods has varied from 10·1 to 11·5, as against 35·5 for sexually produced eggs. Despite this reduction in fertility, the actual reproductive potential is not so much reduced, because all the parthenogenetically produced offspring in all generations have been females and therefore potential egg producers. Unlike the findings of some other workers[2,9] on grasshoppers, my results for locusts show that there is only a slight (approximately 10 per cent) reduction in the percentage of parthenogenetically produced hoppers which reach the adult stage (Table 3).

Bugini[10] says that in some silkworms the parthenogenetic tendency is transmitted and accentuated by heredity; but, unless a reduction from 37 to 30 days (in the F_3 generation) in the time required to reach sexual maturation and oviposit can be regarded as significant, there is no evidence to show that parthenogenesis is being accentuated and transmitted in *Schistocerca gregaria*.

Since I have been successful in rearing four generations of this locust parthenogenetically, I feel that there is a possibility that thelytokous parthenogenesis may play a part in the preservation of the species when isolated in the solitary phase.

I would like to express my thanks to the Anti-Locust Research Centre, London, S.W.7, for the original stock of locusts.

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Weight Relationships among Animal Viruses

The most certain estimates of particle size in the case of animal viruses are probably those based on ultra-centrifugation or diffusion measurements coupled with biological assay. Apart from exceptional cases when material of unusual high titre is available, only a combination of the biological with the physical method can ensure that the physical values refer to the particles having the biological properties studied. Electron microscopy, however, to which this safeguard cannot rigidly be applied, can undoubtedly provide excellent confirmatory evidence.

All the results for particle size obtained by these methods, which relate to the smaller animal viruses and which are known to me, are assembled in Table 1. Some of the measurements have been made recently in this laboratory and details will be published later.

It will be seen from the table that not only do the viruses fall into three groups having sedimentation constants respectively of about 70, 170 and 450 *S*, but also that the range of sedimentation constant distribution within each group is remarkably small.

At this stage no attempt will be made to group the larger viruses, as their sizes are usually given a range which is too wide; for example, influenza virus has been given a range of 76–120 mμ. Equine encephalomyelitis cannot be placed with certainty in the third group with horse-sickness, etc. This virus is known to contain 40 per cent lipoid, which must render accurate estimation of its size difficult.

Attention is directed to the fact that the sedimentation constants of lumpy skin disease, *MEF*$_1$, yellow fever, rift valley fever and African horse-sickness virus have been determined by the same technique.

Assuming on the basis of published electron micrographs that animal viruses are all approximately spherical, their volumes—and consequently their particle weights—will be proportional to the cube of the diameter. The average diameter of each group of viruses is given in the fourth column of Table 1 and the corresponding volumes in mμ^3 in the fifth column. These volumes are approximately in the ratio 1 : 4 : 16, suggesting that viruses in each group may be built from the same number of sub-units, which may differ in composition but have approximately equal volumes.

A clue to the possible nature of the sub-units was provided by Hoyle, Reed and Astbury[1], who showed that the influenza virus may be broken up by treatment with ether into hæmagglutinating and complement-fixing but non-infectious sub-units, approximately 12 mμ in diameter. Similar complement-fixing non-infectious sub-units have now been separated in this laboratory from preparations of rabies virus[2]. The diameter of the rabies sub-units has been estimated by diffusion measurements to be 11–13 mμ.

Calculations from the results in Tables 1 and 2 will show that the volumes of the smallest virus particles are almost exactly four times that of the sub-unit (the complement-fixing antigens) of influenza virus; and it is therefore tempting to conclude that sub-units of this size form the basis of virus structure.

Assuming that the group with the smallest diameter, lumpy skin disease and foot-and-mouth disease, does contain four units, then the corresponding number of units in the others is shown in column 7, and the theoretical diameter in column 8.

Table 1. Sedimentation Constants and Relative Particle Weight of the Smallest Viruses

Virus particle	S (Svedbergs)	Average S	Diam. (mμ)	d^3 (in mμ^3)	$n \times 7{,}300$	Theor. No. of subunits	Theor. d (in mμ)
Foot-and-mouth disease	70 (refs. 3 and 4)	70	19·4	7,300	1	4	19·4
Lumpy skin disease	70 (ref. 5)						
Theiler's virus	160–170 (ref. 6)	169	30·44	28,220	3·78	16	30·78
Coxsackie virus	167 (ref. 7)						
Poliomyelitis *MEF*$_1$	163–180 (ref. 8)						
Yellow fever	167 (ref. 9)						
Horse-sickness, neurotropic	466–470 (ref. 10)	449	49·5	121,300	16·6	64	48·9
Rift Valley fever, viscerotropic	412–476 (ref. 9)						

Table 2. Particle Diameters of the Soluble Antigens of Influenza and Rabies

e, determined by electron microscopy; d, determined by diffusion measurements

Soluble antigen of:	Particle size d (in mμ)	d^3 (in mμ^3)
Influenza e (ref. 1)	12	1,728
Rabies d (ref. 2)	11–13	

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A Method of isolating Soft-rotting Bacteria from Soils

In the course of work carried out at the North of Scotland College of Agriculture on bacterial soft rot of potatoes (*Bacterium carotovorum* (L. R. Jones) Lehmann and Neumann), it was found difficult to isolate the causal organism from naturally infected tubers if infection had occurred through wounds. In most cases only secondary saprophytic bacteria could be isolated. Where infection had occurred through lenticels, soft-rotting bacteria were readily isolated. This was confirmed in laboratory experiments.

As a result, a method was devised for isolating soft-rotting bacteria from soils. 5 gm. of the soil to be tested was shaken up with 250 ml. sterile water. Eight immature potato tubers of the variety Ulster Chieftain, freshly dug and free from surface wounds, were washed in tap water, dipped in methylated spirit, surface-sterilized by immersion for 30 min. in a 1 : 20 solution of sodium hypochlorite dairy disinfectant and then washed for 5 min. in sterile water. Four of the tubers were placed in the soil suspension for 5 min. and four were placed in sterile water as controls. All tubers were then incubated separately for 48 hr. in small glass jars at a relative humidity of 100 per cent and a temperature of 26° C. To isolate soft-rotting bacteria, a visibly infected tuber was washed with tap water and cut lengthwise with a sterile scalpel. A cut was then made in the healthy tissue of the exposed surface so that the half-tuber could be split across to expose a rotted area. This course was taken to avoid contamination by the scalpel. A small piece of rotted tissue was taken from the extremity of the rot, transferred to sterile water in a test-tube and left for thirty minutes. The bacterial suspension so obtained was streaked on to nutrient agar and the bacteria from Gram-negative colonies were isolated. Each isolate was inoculated into freshly cut sterile slices of potato tuber to determine its pathogenicity.

Twenty soil samples, obtained from the Macaulay Institute for Soil Research, were tested by this method for the presence of soft-rotting bacteria. The samples were taken from different types of soil in the north of Scotland and at different stages in the normal seven-course rotation. In every case soft-rots developed in all the inoculated tubers as a result of lenticel infections, and pathogenic bacteria were isolated. The controls remained healthy. This method proved quicker and more reliable than that described by Leach[1], in which a soil suspension was inoculated into potato tubers by the 'hole and plug' method.

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The Autumn Flush of *Drosophila* (Diptera)

During routine trapping with apple bait in two mainly deciduous woods at Liberton, near Edinburgh in 1950, a sudden large increase in numbers of adult *Drosophila* was caught early in November. Two traps on the ground and exposed during October 31–November 7, 1950, gave the usual few adults, namely, 52 (38 *D. subobscura*, 7 *D. obscura*, 1♂ *D. silvestris* n.sp., 1♀ *D. tristis*, 2 *D. phalerata*, 3 *D. funebris*), whereas the two replacements exposed November 7–14, 1950, caught 970 *Drosophila* (867 *D. subobscura*, 56 *D. obscura*, 5♀ *D. silvestris*, 25 *D. tristis*, 2 *D. ambigua*, 5 *D. phalerata*, 9 *D. funebris*, 1♀ *D. cameraria*) (sex signs are given when only one sex occurred). The increase was obviously due mainly to one species, *D. subobscura*. Similar large numbers were obtained at other sites at the same time. When next exposed,

December 6–12, 1950, there were 416 *Drosophila* in the two traps (320 of the 325 examined being *D. subobscura*). Trapping continued until January 24, 1951, and again from February 7, 1951; but up to February 22 flies were very few or absent, doubtless because the temperature remained mostly below 40° F. (4·4° C.), the approximate threshold temperature of activity for *D. subobscura*, the hardiest species. During the period February 22–March 1, 1951, however, the two traps caught 309 flies (298 *D. subobscura*, 3♂ *D. obscura*, 7 *D. cameraria* and 1♂ *Parascaptomyza disticha*), and large numbers again occurred during March 1–3, 1951 (261 *D. subobscura*, 1♂ *D. obscura*, 2♂ *D. tristis* and 4 *D. cameraria*).

The trapping was repeated at the same two sites in 1951, starting on October 23, 1951, with the following results:

	Oct. 23–30, 1951	Oct. 30–Nov. 6, 1951	Nov. 6–13, 1951	Nov. 13–20, 1951	Nov. 20–27, 1951
D. subobscura	20	12	60	1,061	1♂
D. obscura	11♀	15	8	48	—
D. silvestris	40	34	8	14	—
D. tristis	1♀	—	1♂	12	—
D. ambigua	—	—	—	1♀	—
D. phalerata	—	2	—	2	—
D. funebris	—	1♀	2	1♀	—
Total	72	64	79	1,139	1

The next two weeks yielded only 14 *D. subobscura* and nil flies respectively; but with the two traps out during December 14–21, 1951, there was a second flush of 1,496 *Drosophila* (1,472 *D. subobscura*, 15 *D. obscura*, 7 *D. tristis*, 2 *D. cameraria*). The traps were out until March 7, 1952, being renewed every seven days, but there was no further flush, although higher numbers than usual were obtained during the three weeks from February 15, 1952 (186, 209 and 119 *Drosophila* respectively, all being *D. subobscura* except 7 *D. obscura* and 2♀ *D. tristis*).

During 1952 traps were out at various heights in trees and at their bases at Dalkeith. A flush was experienced with traps exposed during October 3–10, 1952 (previous traps out every other week, the last during September 19–26). Traps were then out continuously from October 17, 1952, and a second flush occurred within the period December 5–12, 1952.

It thus appears that the autumn flush is an annual phenomenon in the Edinburgh district. Its causes and whether it occurs over the whole week or over a more restricted period can only be solved by day-to-day observations, which cannot at present be undertaken, owing to pressure of other work. The cause of the initial flush appears to be independent of temperature and of leaf-fall of trees; but the repeat flushes are probably a result of higher temperatures after cold periods. The occurrence of such sudden temporary fluctuations in numbers suggests that the population dynamics of this species are not straightforward, and that caution is necessary in arriving at any opinion as to the effective population size, in Wright's sense[1].

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Observations on the Anal Papillæ of *Culex (culex) fatigans* Wiedemann

The length and shape of the anal papillæ of mosquito larvæ, although a useful aid to other diagnostic factors, have never been a critical specific factor. Kettle[1] has shown that the length of the anal papillæ of *Anopheles sergenti* Theobald is dependent on the saline content of the larval habitat and that small changes in salinity may produce a large difference in the length of the anal papillæ. A similar observation has been noted in Mauritius, where larvæ of *Culex fatigans* Wd. show variation in length of the anal papillæ, according to the salinity of their habitat. This variation may be so great and so striking as to cause some doubt as to the immediate identification of the larvæ.

Fourth-stage larvæ of *C. fatigans* were found breeding profusely in a small tin, partially filled with foul-smelling water and rotting leaf debris. The extremely long, lanceolate, anal papillæ were white in colour. A more than cursory examination was needed to establish these larvæ as those of *C. fatigans*. The length of the longer pair of anal papillæ and the siphonal index were estimated; the salinity of the water was calculated. The results obtained were compared with a similar set of results obtained from larvæ breeding in a small concrete tank.

Habitat	Water	*p*H	Salinity (sod. chloride gm./l.)	Average length of papillæ	Siphonal index
Tin can	Dark brown, foul	8·5	0·40	8·0 mm.	3·8–4·2
Concrete tank	Clear	8·0	1·04	3·8 mm.	3·5–4·0

The great increase in length of the anal papillæ may be directly due to the low concentration of halides in the larval habitat; but it must not be overlooked that life in a small container (tin can) may invoke other responses which would lead to the elongation of the anal papillæ.

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Fluorine in the Human Skeleton

In recent chemical tests carried out on the Piltdown skull, the accurate determination of fluorine was of decisive importance. It may therefore be of interest to mention that the discovery of fluorine in the human skeleton has been attributed[1] to Arthur Connell, first professor of chemistry in the University of St. Andrews (1840–62). Further, to quote from a publication of 1864, "as an example of his nicety as an analyst we may refer to his determination of the constituents of Greenockite from a single grain of that mineral"[2].

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St. Andrews.
Nov. 30.

[1] Irvine, Sir J. C., Chemistry Centenary Lecture (United College, St. Andrews), Edinburgh, 1941, p. 15.
[2] *Proc. Roy. Soc.*, **13**, 1 (1864).

FORTHCOMING EVENTS

Monday, December 21

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. Alan Ross: "Ohthere's Northern Voyage: Cwenas and Lakes".

Tuesday, December 22

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. P. E. Montagnon and Mr. A. L. Ruckley: "The Festival Hall Heat Pump".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER (preferably with pass degree or A.R.I.C.), to do chemical analysis associated with grassland and other research—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (December 26).

EXPERIMENTAL or ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. (science) or equivalent), at the Atomic Energy Research Establishment, Harwell, to work on problems associated with fundamental physical and metallurgical studies related to the design of fuel for nuclear reactors—The Establishment Officer, Atomic Energy Research Establishment, Harwell, quoting 2/103/19 (December 26).

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with an honours degree in engineering, physics or mathematics, and some engineering experience) at the Atomic Energy Research Establishment, Harwell, for fundamental studies of nuclear reactor design involving basic engineering investigations in conjunction with nuclear physics aspects—The Establishment Officer, A.E.R.E., Harwell, Berks, quoting 2/103/23 (December 26).

CARTOGRAPHER (preferably geography graduate) FOR THE DEPARTMENT OF GEOGRAPHY—The Secretary of Universi'y Court, The University, Glasgow (December 30).

LECTURER or ASSISTANT LECTURER (with special interest in endocrinology and pharmacology) IN PHYSIOLOGY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (December 31).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least the general certificate of education at advanced level), IN THE CHEMISTRY SECTION, to work mainly on the treatment and recording of field experimental plots—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (January 1).

MUSEUM ASSISTANT (with a degree, including geology to at least pass standard, and an interest in palæontology) IN THE GEOLOGY DEPARTMENT—The Secretary, University College, Gower Street, London, W.C.1 (January 1).

RESEARCH ASSISTANT (graduate with some research experience) IN THE FLUID MOTION LABORATORY, to carry out experimental research on the aerodynamic noise generated by turbulent flows—The Registrar, The University, Manchester (January 1).

VETERINARY RESEARCH OFFICERS (2) (members of the Royal College of Veterinary Surgeons, and with experience in veterinary research and investigation work) at the Ministry of Agriculture, Northern Ireland—The Director of Establishments, Ministry of Finance, Stormont, Belfast (January 1).

EXPERIMENTAL OFFICER (with a pass degree or higher national certificate in engineering or physics, and with experience in design of experimental equipment and of instruments for measuring metal flow) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Mechanical Engineering Research Laboratory, East Kilbride, for work on plastic deformation and cutting of metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.631/53A (January 2).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in chemistry, biochemistry or an allied subject and preferably with research experience in nutrition) IN THE NUTRITION DEPARTMENT—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (January 2).

CHAIR OF CIVIL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 10).

LECTURER (with honours degree and practical or research experience in either civil or mechanical engineering) IN ENGINEERING—The Secretary, The University, Aberdeen (January 12).

CHAIR OF MINING—The Registrar, The University, Sheffield 10 (January 14).

SCIENTIFIC LIAISON OFFICER (with good degree in physics or chemistry, preferably foreign, and with industrial research experience) with the Pakistan High Commission, London—The Educational Attaché, High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1 (January 15).

CHEMIST (with good honours degree or equivalent) for analytical investigational work in the Coal Survey Laboratory, Cardiff—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/718 (January 16).

LECTURER (graduate in science or technology, and with a good knowledge of the theory of structures) IN STRUCTURAL ENGINEERING, to undertake research work on structures, and to assist in lecturing and laboratory work in structural engineering—The Registrar, College of Technology, Manchester 1 (January 20).

CHAIR OF GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (January 30).

LECTURER or ASSISTANT PROFESSOR (with degree of Ph.D., or equivalent, and with special training in embryology and comparative anatomy) OF ZOOLOGY—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (February 1).

LECTURER IN APPLIED MATHEMATICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, February 8).

CHAIR OF BOTANY—The Registrar, University College, Singleton Park, Swansea (February 15).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 31).

ASSISTANT DIRECTOR OF RESEARCH IN THE DEPARTMENT OF ANIMAL PATHOLOGY, University of Cambridge—The Secretary, Faculty of Biology "B", Department of Pathology, Tennis Court Road, Cambridge.

ENGINEER, Grade I (Ref. 510), and an ENGINEER, Grade III (Ref. 511), at the Division of Atomic Energy (Production), for work on major calculations required by design offices concerned with nuclear reactors and factories for producing fissile material—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting appropriate Ref. No.

ENGINEERS and PHYSICISTS, Experimental Officer and Assistant Experimental Officer grades, in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/52A.

LECTURER or ASSISTANT PROFESSOR (qualified to give advanced instruction in one or both of elasticity and theoretical mechanics) of APPLIED MATHEMATICS—Prof. I. R. Pounder, Department of Mathematics, University of Toronto, Toronto, Canada.

PHYSICAL CHEMIST (preferably Ph.D.) for research work on the kinetics of cellulose degradation—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

RESEARCH ASSISTANT (with a degree in engineering or physics) AT THE NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING, to carry out research on heat transfer, refrigeration or aerodynamics, and possibly a small amount of laboratory demonstration—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

SCIENCE GRADUATE (trained in physics or physical chemistry, and preferably with experience in biological work) IN THE BLOOD PRODUCTS LABORATORY—The Secretary, Lister Institute, Elstree, Herts.

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent qualifications, in civil engineering or science, with geology or physics as principal subject), at the Royal Air Force Station, Cardington, for duties which include investigations into runway, building and road sites, and experimental work in soils engineering laboratory—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.240/53.

SENIOR RESEARCH ASSISTANT (male) (with either a good honours degree in a biological science, or a degree in agriculture with post-graduate training in poultry husbandry, and with previous research experience), for programme of research on poultry husbandry, and an ASSISTANT (male), for poultry experimental work, with particular reference to table poultry production and marketing—The Bursar, Harper Adams Agricultural College, Newport, Shropshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Experimental and Research Station, Cheshunt, Herts. Annual Report (Thirty-Eighth Year), 1952. Pp. 88+2 plates. (Cheshunt: Nursery and Market Garden Industries' Development Society, Limited, 1953.) [2010

Aero Research Technical Notes. Bulletin No. 129: The Connecting of Pipes and Tubes with "Araldite": a Description of the Mitchell System. Pp. 4. (Duxford, Cambridge: Aero Research, Ltd., 1953.) [2010

Transactions of The Royal Society of Edinburgh. Vol. 62—Part 2—(No. 13), 1951–53: An Investigation into the Design and Performance of Electric Fish-Screens and an Electric Fish-Counter. By N. G. Lethlean. Pp. 479–526+2 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 13*s*. 6*d*. [2010

International Association for the Exchange of Students for Technical Experience. Sixth Annual Report. Pp. 66. (London: International Association for the Exchange of Students for Technical Experience, 1953.) [2110

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.), No. 12: Development in *Podocarpus Nivalis* in Relation to other Podocarps. I. Gametophytes and Fertilization. By Patricia Boyle and J. Doyle. Pp. 179–205. (Dublin: Royal Dublin Society, 1953.) 6*s*. [2110

Economic Proceedings of the Royal Dublin Society. Vol. 4, No. 2: The Physical Characteristics of Butter Produced by the Alfa Process. By J. Lyons and M. J. O'Shea. Pp. 65–74+plate 14. (Dublin: Royal Dublin Society, 1953.) 3*s*. [2110

Forestry Commission. Forest Record No. 19: The Manufacture of Wood Charcoal in Great Britain. By L. Reynolds. Pp. 12+8 plates. 1*s*. 3*d*. net. Forest Record No. 21: Use and Manufacture of Wood Flour. By L. Reynolds. Pp. 6. 6*d*. net. Leaflet No. 31: The Grey Squirrel: a Woodland Pest. Pp. 16. 9*d*. net. (London: H.M. Stationery Office, 1953.) [2110

Forestry Commission. Britain's Forests. Glentress. Pp. 18. 1*s*. net. Drumtochty. Pp. 20. 1*s*. 3*d*. net. (London: H.M. Stationery Office, 1953.) [2110

Forestry Commission. Census Report No. 5: Census of Woodlands 1947–49, Woods of Five Acres and Over; English County Details. Pp. vi+270. (London: H.M. Stationery Office, 1953.) 12*s*. 6*d*. net. [2110

Agricultural Research Institute of Northern Ireland. Twenty-Sixth Annual Report, 1952–53. Pp. 38. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1953.) [2310

Department of Scientific and Industrial Research. National Building Studies. Special Report No. 21: Productivity in House-Building. Second Report. By W. J. Reiners and H. F. Broughton. Pp. iv+38. (London: H.M. Stationery Office, 1953.) 1s. 9d. net. [2610

Atomic Energy Progress Notes, Vol. 1 (Scientific and Industrial). Pp. iii+19. (London: Association of Scientific Workers, 1953.) 2s. 6d. stiff cover to non-association members; 1s. paper cover to members. [2610

Proceedings of the Royal Irish Academy. Vol. 55, Section A, No. 9: Lower Bounds for the Electrostatic Capacity of a Cube. By the Rev. James McMahon. Pp. 133–168. 6s.; Vol. 55, Section A, No. 10: Pure Pseudoscalar Theory of Meson Production. By the Rev. James McConnell. Pp. 169–182. 2s. 6d.; Vol. 55, Section A, No. 11: Applicability of the Weizsäcker-Williams Method to Meson Fields. By the Rev. James McConnell. Pp. 183–194. 2s.; Vol. 55, Section B, No. 15: The Constitution of Arabic Acid. By Thomas Dillon, Donnachadha F. O'Ceallachain and Proinsias O'Colla. Pp. 331–344. 2s. (Dublin: Hodges, Figgis and Co., Ltd., 1953.) [2610

Ministry of Labour and National Service. Factory Department. Factory Form 324: Precautions in the use of Ionising Radiations in Industry. Pp. ii+18. (London: H.M. Stationery Office, 1953.) 2s. net. [2610

Imperial College of Science and Technology. Research Report of the Royal College of Science 1950–52. Pp. iv+56+14 plates. (London: Imperial College of Science and Technology, 1953.) [2710

International Association of University Professors and Lecturers. Communication 23. (September, 1953.) Pp. 73+2 plates. (London: International Association of University Professors and Lecturers, 1953.) 1s. 6d. [2810

Scottish Marine Biological Association. Annual Report 1952–53. Pp. 39. (Millport: Scottish Marine Biological Association, 1953.) [2910

A Century's Changes of Outlook. By the Rt. Hon. Viscount Samuel. (The Hibbert Centenary Lecture.) Pp. 22. (Cambridge: At the University Press, 1953.) 2s. 6d. net. [2910

National Institute of Economic and Social Research, London. Register of Research in the Social Sciences in Progress and in Plan. No. 10, 1952–53, with a Directory of Research Institutions. Edited by Feodora Stone. (Cambridge: At the University Press, 1953.) 6s. [2910

Department of Scientific and Industrial Research. Forest Products Research. Bulletin No. 28: The Strength Properties of Timber. By F. H. Armstrong. Pp. vi+42+4 plates. (London: H.M. Stationery Office, 1953.) 2s. net. [3010

General Register Office. Studies on Medical and Population Subjects No. 7. General Practitioners' Records: an Analysis of the Clinical Records of Eight Practices During the Period April, 1951 to March, 1952. By Dr. W. P. D. Logan. Pp. viii+132. (London: H.M. Stationery Office, 1953.) 8s. 6d. net. [3010

Deep Sea Research. Vol. 1, No. 1. (October 1953.) Pp. 64. A quarterly journal. (London: Pergamon Press, Ltd., 1953.) [3010

Glacial Drifts and the Undermelt Theory. By R. G. Carruthers. Pp. vi+42+4 plates. (Newcastle-upon-Tyne: Harold Hill and Son, Ltd., 1953.) 2s. 6d. net. [311

Some Aspects of the Conflict Between Science and Religion. By Prof. H. H. Price. (The Seventh Arthur Stanley Eddington Memorial Lecture, 3 November 1953.) Pp. v+54. (Cambridge: At the University Press, 1953.) 3s. 6d. net. [411

Other Countries

Smithsonian Institution. Bureau of American Ethnology. Bulletin 153: La Venta, Tabasco: a Study of Olmec Ceramics and Art. By Philip Drucker. (With a Chapter on Structural Investigations in 1943. by Waldo R. Wedel, and Appendix on Technological Analysis by Anna O. Shepard.) Pp. x+257+66 plates. (Washington: Government Printing Office, 1952.) 1.25 dollars. [2010

Smithsonian Institution. Bureau of American Ethnology. Bulletin 145: The Indian Tribes of North America. By John R. Swanton. Pp. vi+726. (Washington: Government Printing Office, 1952.) 3.50 dollars (cloth). [2010

Bibliografo över J. J. Berzelius. Utgiven av Kungl. Svenska Vetenskapsakademien. Förra delen. Tryckta Arbeten av och om Berzelius. Supplement 2. Genom Arne Holmberg. Pp. x+34. Senare delen. Manuskript: Supplement. Genom Arne Holmberg. Pp. xii+32. (Stockholm: Svenska Vetenskapsakademien, 1953.) [2010

East Africa High Commission. A Survey of Research and Scientific Services in East Africa 1947–1956. By E. B. Worthington. Pp. iii+79. (Paper No. 6.) (Nairobi: East Africa High Commission.) [2010

Indian Council for Agricultural Research. Scientific Monograph No. 18: Further Studies on Cereal Rusts in India, Part 2. By Prof. K. C. Mehta. Pp. vi+368+5 plates. (Delhi: Manager of Publications, 1952.) 10/2/– rupees; 16s. [2010

Forest Research in India, 1949–50. Part 1: The Forest Research Institute. Pp. iii+107. 10/2/– rupees; 16s. Part 2: Reports for Burma and Indian States. Pp. iii+59. 5/2/– rupees; 8s. (Delhi: Manager of Publications, 1953.) [2010

Memoirs of the India Meteorological Department. Vol. 29, Part 6: Hydrometeorology of the Damodar Catchment. By S. K. Pramanik and K. N. Rao. Pp. iv+231–385. (Delhi: Manager of Publications, 1953.) 13/2/– rupees. [2010

United States: Department of the Interior. Geological Survey. Professional Paper 217: Configuration of the Bedrock Surface of the District of Columbia and Vicinity. By N. H. Darton. Pp. vi+42. 1.25 dollars. Professional Paper 218: Geology and Mineral Resources of the Hardin and Brussels Quadrangles (Illinois). By William W. Rubey. Pp. v+179+21 plates. 2.25 dollars. Professional Paper 226: The Geology and Geography of the Paunsaugunt Region, Utah. (A Survey of Parts of Garfield and Kane Counties.) By Herbert E. Gregory. Pp. vi+116+5 plates. 2.25 dollars. Professional Paper 233–A: Fresh-Water Mollusks of Cretaceous Age from Montana and Wyoming. By Teng-Chien Yen. Pp. 1+20+2 plates. 45 cents. Professional Paper 233–C: Upper Silurian Brachiopods from Southeastern Alaska. By Edwin Kirk and Thomas W. Amsden. Pp. iii+14+4 plates. 55 cents. Professional Paper 233–D: Devonian and Mississippian Rocks of Central Arizona. By John W. Huddle and Ernest Dobrovolny. Pp. iii+46. 65 cents. Professional Paper 234–A: Ostracoda from Wells in North Carolina. Part 1: Cenozoic Ostracoda. By Frederick M. Swain. Pp. iii+58+7 plates. 75 cents. (Washington: Government Printing Office, 1950–1952.) [2010

United States: Department of the Interior. Geological Survey. Professional Paper 234–B: Ostracoda from Wells in North Carolina. Part 2: Mesozoic Ostracoda. By Frederick M. Swain. Pp. iii+59–93+plates 8 and 9. 40 cents. Professional Paper 236–A: Foraminifera From the Arctic Slope of Alaska. (General Introduction and Part 1, Triassic Foraminifera.) By Helen Tappan. Pp. iii+17+5 plates. 50 cents. Professional Paper 237: Geology of Clinton County Magnetite District, New York. By A. Williams Postel. Pp. v+83. 1.25 dollars. Professional Paper 240–A: Foraminifera of the Lodo Formation, Central California. (General Introduction and Part 1, Arenaceous Foraminifera.) By M. C. Israelsky. Pp. iii+29+11 plates. 1.25 dollars. Professional Paper 241: Vicksburg (Oligocene) Smaller Foraminifera from Mississippi. By Ruth Todd. Pp. iii+53+6 plates. n.p. Professional Paper 243–B: Tertiary Stratigraphy of South Carolina. By C. Wythe Cooke and F. Stearns MacNeil. Pp. iii+11. 15 cents. (Washington: Government Printing Office, 1950–1952.) [2010

Cawthron Institute, Nelson, New Zealand. Annual Report 1952–53. Pp. 42+2 plates. (Nelson, N.Z.: Cawthron Institute, 1953.) [2110

State of California: Department of Fish and Game. Fish Bulletin No. 92: Studies on Fish Preservation at the Contra Costa Steam Plant of the Pacific Gas and Electric Company. By James E. Kerr. Pp. 66. (San Francisco: Department of Fish and Game, 1953.) [2110

Department of the Army: Corps of Engineers. Beach Erosion Board: Office of the Chief of Engineers. Technical Memorandum No. 34: Development and Field Tests of a Sampler for Suspended Sediment in Wave Action. By George M. Watts. Pp. iv+41. Technical Memorandum No. 39: Areal and Seasonal Variations in Beach and Nearshore Sediments at La Jolla, California. By Douglas L. Inman. Pp. ii+48. (Washington, D.C.: Office, Chief of Engineers, 1953.) [2110

Université de Paris: Faculté de Pharmacie. l'Action du Soufre en Présence du Chlorure d'Aluminium sur le Benzene et Plusieurs de ses Dérivés. Thèse pour l'obtention du grade de Docteur de l'Université de Paris (Pharmacie), présentée par Iradj Lalezari. Pp. x+40. (Paris: Université de Paris, Faculté de Pharmacie, 1953.) [2110

Federal Funds for Science. 2: The Federal Research and Development Budget, Fiscal Years 1952 and 1953. Pp. ii+44. (Washington: National Science Foundation, 1953.) [2210

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1952. Von E. Rübel und W. Lüdi. Pp. 128. (Zürich: F. G. Rübel in Zürich, 1953.) [2310

Proceedings of the Western Computer Conference held by the Joint IRE-AIEE-ACM Computer Conference Committee, Los Angeles, California, February 4–6, 1953. Pp. 231. (New York: Institute of Radio Engineers, Inc., 1953.) 3.50 dollars. [2310

Thirty-Sixth Annual Report of the National Research Council of Canada, 1952–53. Pp. 54. (Ottawa: Queen's Printer, 1953.) [2310

Veroffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die Monate April, Mai, Juni, 1953. Pp. 50. (Freiburg I.Br.: Fraunhofer Institut, 1953.) [2310

Deutscher Wetterdienst. Deutsches Meteorologisches Jahrbuch U.S.-Zone, 1951. Pp. xxiv+192. (Bad Kissingen: Deutscher Wetterdienst, 1953.) [2310

Mitteilungen des Deutschen Wetterdienstes. Nummer 3 (September 1953): Vergleichsmessungen des Ozongehalts in Oberstdorf und auf dem Nebelhorn. Von Dipl.-Ing. E. Obenland. Pp. 15. Nummer 4 (October 1953): Phänologische Kreisbeschreibungen. Von Dr. S. Uhlig. Pp. 24. (Bad Kissingen: Deutschen Wetterdienstes, 1953.) [2310

Museum of Comparative Zoology at Harvard College. Breviora. No. 18: Characters and Synonymies Among the Genera of Ants, Part 2. By William L. Brown, Jr. No. 19: Lower Cretaceous Nautiloids from Texas. By Bernhard Kummel. Pp. 12+2 plates. No. 20: Lower Triassic Salt Range Nautiloids. By Bernhard Kummel. Pp. 8+2 plates. No. 21: The Ancestry of the Family Nautilidae. By Bernhard Kummel. Pp. 7+1 plate. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [2310

University of Illinois Engineering Experiment Station. Reprint Series No. 51: Progress Reports of Investigation of Railroad Rails and Joint Bars. By R. E. Cramer and R. S. Jensen. Pp. 31. (University of Illinois Bulletin.) (Urbana: University of Illinois, 1953.) 30 cents. [2310

University of Illinois Engineering Experiment Station. Bulletin Series No. 411: The Dielectric Constant and Dissipation Factor of Soda-Potassium-Silica Glasses at Frequencies of 1 to 300 Kilocycles at Room Temperatures. By G. F. Stockdale. Pp. 27. 30 cents. Bulletin Series No. 412: Heat Emission Characteristics of Warm-Air Perimeter Heating Ducts. By John R. Jamieson, Robert W. Roose, Herbert T. Gilkey and Seichi Konzo. Pp. 84. 80 cents. Bulletin No. 413: Transport of Momentum and Heat in Turbulent Jets. By Lloyd G. Alexander, Thomas Baron and Edward W. Comings. Pp. 88. 75 cents. Bulletin Series 414: Frequency Analysis of Hydrologic Data with Special Application to Rainfall Intensities. By Ven Te Chow. Pp. 80. 80 cents. (Urbana: University of Illinois, 1953.) [2310

Durban Museum Novitates. Vol. 4, Part 5: Some Systematic Notes on the Long-Fingered Bats of the Genus Miniopterus Bonaparte Occurring in South Africa and Madagascar. By Dr. David L. Harrison. Pp. 65–75. (Durban: Durban Museum and Art Gallery, 1953.) 2s. 6d. net. [2610

A Preliminary List of the Birds of Natal and Zululand, with a Short Account of the Status of each. Prepared by P. A. Clancey. Pp. 55. (Durban: Durban Museum, 1953.) [2610

Notas de Física. No. 12: Atomic Theory of Liquid Helium. By R. P. Feynman. Pp. 5. (Rio de Janeiro: Centro Brasileiro de Pesquisas Físicas, 1953.) [2610

Department of Agriculture, Jamaica. Investigations, 1952. Bulletin No. 50 (New Series). Pp. 122. (Jamaica: Department of Agriculture, 1953.) 2s. [2610

University College, Ibadan, Nigeria. Calendar, 1953–54. Pp. 55. (Ibadan: University College, 1953.) [2810